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THESIS

ISSUES IN NAVY MANAGEMENT OF MAJOR WEAPON SYSTEMS WARRANTIES

by

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December 1986

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Issues in Navy Management of Major Weapon Systems Warranties

by

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ABSTRACT

The purpose of this research was to investigate problems in management of Navy warranty contract clauses, as the result of recent legislation mandating cost effective warranty coverage for major weapon systems. This investigation involved the following: 1) Identification of warranty benefits and recent warranty legislation, 2) Review and comparison of Services and Navy Systems Command implementation procedures, and 3) Analysis of five warranty contract clauses. The methodology for this research involved current literature and interviews with Government and industry officials involved with warranty issues.

As a result of this analysis, the conclusions are as follows: 1) Actual costs and estimating techniques need definition and refinement, 2) Navy implementation procedures must be integrated and coordinated, and 3) Early on planning in weapon system development is required to avoid potential problems. This study recommends that a single warranty management information system be established. Management procedures and reporting formats should be standardized as much as possible.

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I. INTRODUCTION

A. AREA OF RESEARCH

With the implementation of Section 2403 to Title 10 United States Code, Weapon Systems Warranty Act, and Department of Defense Federal Acquisition Regulation Supplement (DFARS) Subpart 46.7, quality and performance risks, which were formerly self-insured, have shifted from the Government to weapon systems contractors. This shift in risk assumption has translated into increased warranty coverage for major weapon systems procured by the Department of Defense. This thesis concerns the Navy administration of this warranty coverage.

B. DISCUSSION

Using warranties to assign some type of quality accountability has long been a common practice in private industry, while in the Department of Defense, (DOD), the use of warranties has only been sporadically applied since 1964. Ideally, warranty coverage maintains the quality of a product over its useful life. The seller assumes the majority of the risk that the product, whether it be an automobile or a complex fighter aircraft, will operate as intended.

With increasing weapon system costs and the horror stories of unreliable weapon systems, such as the Air Force

C-5A and the Army DIVAD Tank, Congress has recently legislated that DOD implement a major weapon systems warranty policy.

Applying warranties to state-of-the-art complex weapon systems is an extremely difficult task. There are numerous variables which have to be taken into account. Using warranties in a haphazard manner could cost the Government significant sums of money and time. In the DOD's case, improper application of warranties could have detrimental effects on national defense through readiness.

In order to realize the full benefits of warranties, the Navy must carefully analyze the management of warranties. Spending millions of dollars to obtain warranty coverage does not automatically ensure the quality of a weapon system. If the Fleet is to receive quality benefits, warranties must be made to work in a cost effective manner. Effective warranty management is the crucial link for ensuring this happens.

C. OBJECTIVES OF THE RESEARCH

The main objectives of this thesis are as follows:

1. Identify warranty management procedures implemented to date.
2. Review similar warranty contract clauses to highlight variability in contract clause elements.
3. Discern any actual or potential problems from warranty procedures developed or implemented and from contract clauses enacted.

D. RESEARCH QUESTIONS

The primary research question is as follows:

What are the key problems in management of Navy warranty clauses as the result of new regulations mandating cost effective warranty coverage for major weapon systems and how might warranty administration be improved?

Subsidiary research questions are as follows:

1. What is a warranty and how is it applied to Navy weapon systems?

2. What are current Navy warranty administration procedures and what are the critical problems in applying these procedures?

3. What are the principal variables or factors which affect warranty administration?

4. What significant court cases and Armed Services Board of Contract Appeals cases have occurred involving warranty administration of major weapon systems, and what precedents can be applied?

5. What modifications could be made to existing warranty provisions in order to enhance the administration of such warranties?

E. RESEARCH METHODOLOGY

The basic research for this thesis was developed from a comprehensive study of current literature and from interviews with the following:

1. Members of the Navy Warranty Ad Hoc Group.

2. Navy Systems Commands' Warranty Team members.

3. Recommended technical and contracting personnel at the Hardware Systems Commands, Ships Parts Control Center and Aviation Supply Office.

4. Officer-in-Charge, U.S. Air Force Product Performance Agreement Center, Wright-Patterson Air Force Base, Ohio.

5. Director, Warranty Management, Policy and Plans, Headquarters, Department of the Army, Washington D.C..

6. Various Audit agencies including:

   a. General Accounting Office, (Detroit Regional Office)
   b. Department of Defense Inspector General, Auditing
   c. Navy Inspector General
   d. Naval Audit Service Southwest Region
   e. Air Force Audit Agency, Norton Air Force Base, CA

7. Director of Contracts at selected major weapon systems contractors.

Appendix A provides a list of individuals who either were interviewed or provided information for this research. Appendix B provides a list of the general questions used in the interviews.

In addition to the above, five warranty contract clauses from the following major system programs were reviewed.

1. HARM Missile System
2. SPARROW Missile System
3. SIDEWINDER Missile System
4. TOMAHAWK Missile System
5. Commercial Communications Satellite from Hughes Aircraft Company

These programs were selected based on recommendations from knowledgeable personnel familiar with warranty coverage from Navy Systems Commands. The results of the study reflect those actions and issues that were in existence as of July 1986.

F. SCOPE OF THE THESIS

The general direction of the thesis is to provide a brief overview of the contractual aspects of Navy warranty administration of major weapon systems, to review warranty management procedures that are currently used or being developed, and to analyze the impact of warranty contract clause elements on warranty administration. This thesis does not include shipbuilding or ship overhaul warranty administration except in a very basic overview. No attempt was made to collect raw data at the Fleet level because of the newness of the warranty requirement.

G. DEFINITIONS

For the purposes of this study, the following definitions are provided:

1. Warranty--The term warranty is used in a number of contexts. Its most restrictive meaning occurs in the traditional Government contract warranty clause (less frequently referred to as a Guaranty clause) which simply gives the Government a remedy for patent defects discovered after acceptance. The reason for including such a clause is to overcome the finality of acceptance. Another meaning, the most common commercial use of the term, is that a warranty is a promise of the seller regarding the quality of the goods. In this sense the term is used to determine when a defect exists rather than to provide a remedy for the defect. [1:614]

2. Material and Workmanship--This warranty is designed to provide an incentive for the contractor to consistently produce a weapon system that conforms to all manufacturing drawings and quality standards. The warranty is most important during the early periods of production. [2:9]

3. Design and manufacturing requirements--These terms mean the structural and engineering plans and

manufacturing particulars, including precise measurements, tolerances, materials and finished product tests for the weapon system being produced. [3:46.7-2]

4. Essential performance requirements--These terms mean the operating capabilities and maintenance and reliability characteristics of a weapon system that are determined by the Secretary of Defense (or delegated authority) to be necessary for it to fulfill the military requirement for which the system is designed. [3:46.7-3]

5. Initial production quantity--These terms mean the number of units of a weapon system contracted for in the first program year of full-scale production. [3:46.7-3]

6. Mature full-scale production--These terms mean the follow-on production of a weapon system after manufacture of the lesser of the initial production quantity or one-tenth of the eventual total production quantity. [3:46.7-3]

7. Prime Contractor--These terms mean a party that enters into an agreement directly with the United States to furnish a system or a major subsystem. [3:46.7-3]

8. Weapon System--These terms mean a system or major subsystem used directly by the armed forces to carry out combat missions. By way of illustration, the term "weapon system" includes, but is not limited to the following, if intended for use in carrying out combat missions: tracked and wheeled combat vehicles; self-propelled, towed and fixed guns, howitzers and mortars; helicopters; naval vessels; . . . [3:46.7-3]

A "weapon system," however, does not include the following: [4:2]

a. Support equipment related to the items listed above, such as ground handling equipment, training devices and their accessories, or ammunition (unless an effective warranty for the weapon system would require inclusion of such items);

b. Commercial items sold in substantial quantities to the general public;

c. Any system that costs less than $100,000 per unit or whose eventual total procurement cost is less than $10,000,000;

d. Foreign Military Sales (FMS) contracts (the Government may, however, obtain warranties requested by an FMS purchaser if a mutually satisfactory price and arrangement can be negotiated).

H. ORGANIZATION OF THE STUDY

Chapter II describes the basic concept of warranties, how they are used within contractual requirements, and a brief explanation of the recent legislation directing cost effective warranty coverage. Chapter III presents how each service implemented the new warranty legislation through service directives (at the time of this study both Navy and Air Force instructions were in draft stage). From there, an analysis is made of how the Navy Systems Commands are implementing warranty legislation. Using a case study approach, Chapter IV shows how various contract clauses are put together as the result of service implementation brought out in Chapter III. The primary idea is to bring out the important variables or factors of a warranty clause as analyzed in the case study. The five contract clauses are from the following programs: HARM, SPARROW, SIDEWINDER, TOMAHAWK, and a commercial warranty for communications spacecraft from Hughes Aircraft Company. Chapter V brings out the various problems in warranty administration from implementing the new law to applying contract clauses. This is, in fact, basically the results of the research presented

in previous chapters. Chapter VI points out some conclusions and recommendations for further study.

II. BACKGROUND

A. CHAPTER OVERVIEW

This chapter discusses the types of warranties available to the Department of Defense (DOD) and the benefits to be gained from warranty application. To demonstrate the evolution of warranty regulations to the present, this chapter highlights recent Congressional legislation mandating warranty coverage of major weapon systems. Recent military experience and the contractual application of warranties is shown to provide a background to warranty implementation by the various services.

B. WARRANTY TYPES

In order to understand issues concerning warranties, one must first understand what a warranty is. The Federal Acquisition Regulations provides this definition:

> A warranty means a promise or affirmation given by a contractor to the government regarding the nature, usefulness, or conditions of supplies or performance of services furnished under the contract. [5:46-9]

Along with the general definition above, warranties are further broken down into two categories--implied and express. An implied warranty has two main descriptions: 1. That the owner maintains title to the product and has the authority to sell it. 2. That the product meets the standards of that particular industry and is suitable for

use. [6:589] This type of warranty is a standard practice throughout private industry. In an express warranty, the seller warrants that the material delivered will meet the order description or required performance. [6:589]

From the above definitions it can be inferred that basically a warranty is like an insurance policy for the buyer to guarantee certain product requirements. The seller essentially assumes the risk that the product may fail during the warranty coverage period. With this assumption of additional risk, the seller generally charges the buyer increased costs for this deferred liability. What is currently in question is should the Government pay additional costs, and if so, how much should these warranties cost.

Within the Federal Government, two subsets of warranties are used primarily: design warranties and performance warranties. In a design warranty the contractor warrants that the design of the product meets the specifications provided by the buyer. In a performance warranty the contractor warrants that the product will perform its intended function at a certain level for a specified period. [7:25]

Within the express warranty concept, three of the more commonly used warranty plans in DOD acquisition include: Reliability Improvement Warranty (RIW), Mean Time Between Failure Guarantee (MTBF), and Logistic Support Cost

Commitment (LSC). Table 1 briefly lists the main features of each plan.

The table is not inclusive of warranties used in the DOD. Appendix C provides examples of other warranty variations available for DOD application.

When discussing warranties in DOD acquisition, one must be careful in applying it appropriately. It can have different meanings for the contractor, program manager, technician, buyer, and the person in the field who uses the equipment. When looking at warranty issues, one must determine the type of warranty. Because of the many different types of warranties used by DOD, the warranty issue is far more complex than the warranty for a John Deere tractor.

C. WARRANTY BENEFITS

Prior to discussing any of the issues associated with warranties, it would be appropriate to look at some of the benefits typically thought to be provided by warranties. This allows for a more meaningful comparison to be made.

Deputy Secretary of Defense William H. Taft IV recently high-lighted quality gains by making defense contractors more accountable for product quality through warranties. [9:6] In a recent interview, Rear Admiral Stuart Platt, the Navy's Competition Advocate, espoused the advantages of warranties, particularly as the Navy grows to a 600-ship fleet. Admiral Platt felt that warranties would enhance

TABLE 1

FEATURES OF COMMONLY USED WARRANTY-GUARANTEE PLANS

Features	RIW	RIW/MTBF	LSC
Objective	Secure reliability improvement/ reduce support costs	Achieve stated reliability requirements/ reduce support costs	Achieve stated logistic-cost goal
Method	Contractor repairs or replaces all applicable items that fail during coverage period; implements no-cost ECPs to improve reliability	Same as RIW in addition, contractor provides additional spare units to maintain logistic pipeline when MTBF goals are not met	Normal maintenance; operational test performed to assess LSC; penalty or corrective action required if goals are not achieved
Pricing	Fixed price	Fixed price	Fixed price or limited cost sharing for correction of deficiencies
Incentive	Contractor profits if repair costs are lower than expected because of improved R&M	Similar to RIW, plus possible severe penalty for low MTBF	Award fee if goal is bettered; penalties for poor cost performance

Source: [8:V III]

workmanship on the shop floor and at the same time hold down operating costs. [10:15] From these indications it would appear that DOD upper management is climbing aboard the warranty "band wagon".

At the working level the following provide some of the possible advantages that may be incurred with warranty use.

- Direct or indirect motivation for designing and producing reliable and maintainable equipment. [11:5-62]

- Reduced initial requirements for support equipment, training, and data. [11:5-62]

- Reduced initial logistics problem if contractor repair is at "black box" level. [11:5-62]

- Long-term stabilized workflow for contractor repair work and increased chances for follow-on procurements. [11:5-62]

- Control of operational rather than test parameters. [11:5-62]

- Trade-off potential for guarantee of higher-level parameters, e.g., logistics support costs. [11:5-62]

- Extending contractor's responsibility to field performance. Without a written warranty, the Government assumes all the risks for product performance and support. Under warranty both the Government and the contractor share the risks and rewards. [2:2-1]

- Improving performance, reliability, and quality. If contractors are committed to correcting warranty breaches at their expense, they have a strong motivation to meet or exceed levels of performance. [2:2-1]

- Reducing life cycle costs. Contractors are motivated to reduce repair costs to minimize their liability. This could result in a corresponding reduction of support costs for the Government. [2:2-1]

- Early and rapid resolution of problems. Due to the warranty agreement and possible liabilities, problem areas receive high visibility and gain management attention. [2:2-1]

- Incentive for no-cost engineering change proposals. [2:2-1]

- Realistic estimates of field performance. If contractor projections are overly optimistic, funds from warranty can be depleted rapidly and profits reduced. [2:2-1]

- Improved evaluation of field performance. The contractor is motivated to participate in the early evaluation of field failures. [2:2-1]

While all of the above benefits may not be realized on any one warranty program, any one or combination of them could be a significant step forward.

From a simplistic viewpoint, it would seem that the contractor would be motivated without warranties to carry out the above actions. With most major weapon systems contractors, the Government is the sole customer of the firm or makes up a large percentage of their business. Therefore, should not the Government be treated in a "most favored customer" status and not charged extra for the above benefits.

These benefits or factors could be detrimental to the Government if the warranty is not properly managed. For example, the contractor might stay with "old", proven technology instead of pushing the "leading edge" of technological advances. Reliability may be increased, but overall, long term performance may decrease. The above advantages could also be viewed as disadvantages depending on the criteria used to evaluate the warranty. There may be short term dollar cost savings, but on the other side long term readiness may suffer. Examples of this will be discussed in succeeding chapters.

The above benefits of a warranty are not normally gained without some cost. The contractor providing the warranty

coverage will estimate all costs required to perform the warranty coverage. The warranty price quoted by the contractor would also most likely include a percentage for profit to compensate for additional risk assumption. [12:387]

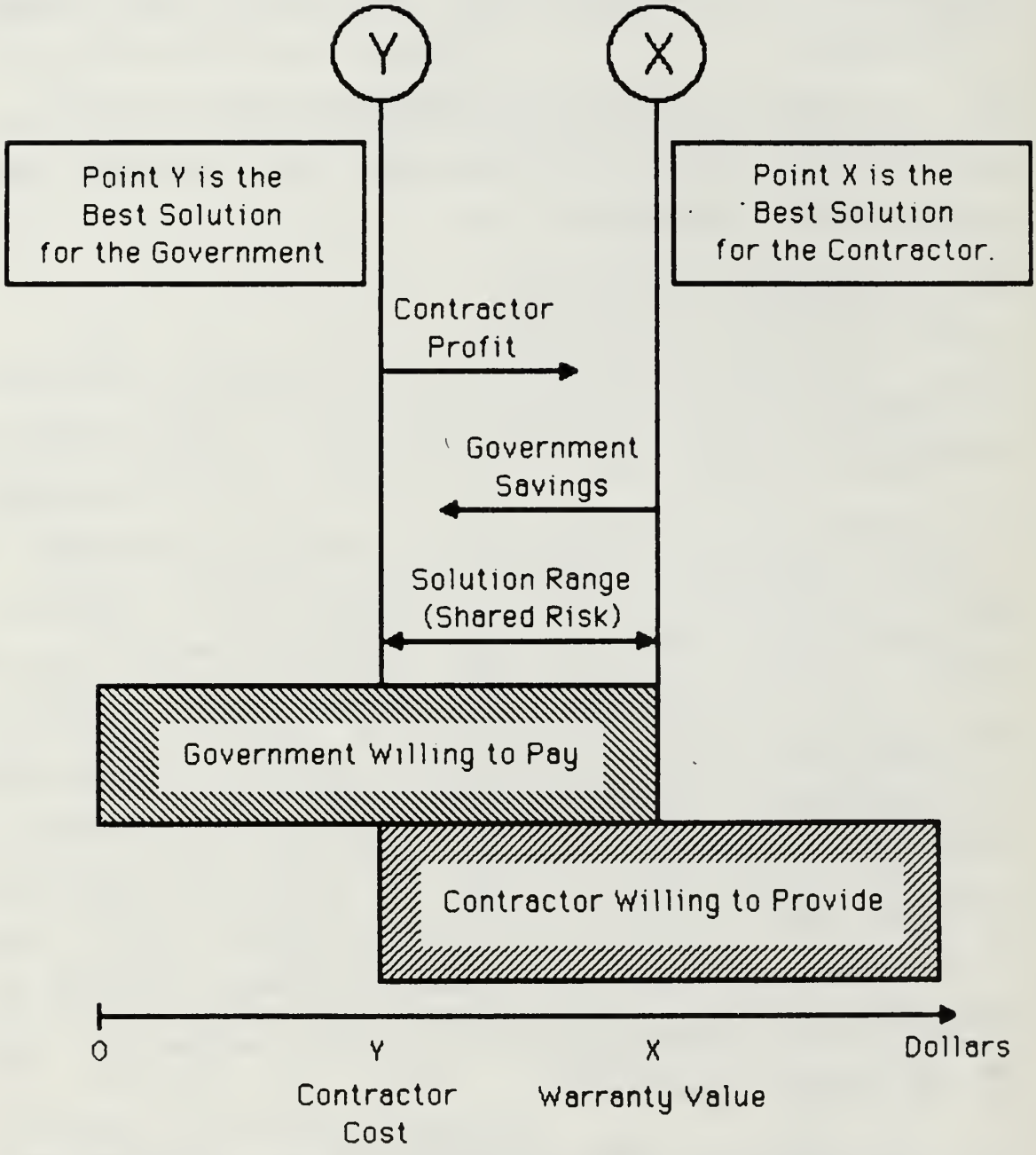
Figure 1 presents a straightforward illustration of warranty cost/benefit from both the Government and the contractor viewpoint.

D. WARRANTY LEGISLATION

The DOD contracts have used warranty provisions for a number of years on a selective basis. Prior to 1984 there were no public laws or procurement regulations mandating warranty use for weapon system. Because of the concept that the Government (the DOD in particular) acted as a self-insurer. The Government assumed the majority of risk.

With a background of public outcry against DOD procurement abuses and increased defense spending, Senator Mark Andrews in November 1983 introduced an amendment to the 1984 Defense Appropriations Act which required written warranties in contracts for weapon systems. [13:63] Despite vigorous DOD and private industry protests, Section 794 of the Defense Appropriations Act of 1984 became law. Section 794 states in part:

> No funds . . . may be obligated or expended for the procurement of a weapon system unless the prime contractor or other contractors for such a system provide the United States with written guarantees. [14:154]



Source: (12:387)

Figure 1. Warranty Cost Benefit Picture

Written guarantees now have the following requirements:

1. Weapon systems and components must conform to contractual performance requirements.

2. The weapon system and its components are to be free from defects that would cause failure to meet performance requirements.

3. In the event of failure, the contractor will bear the cost of achieving required performance. This particular reform was one of the initial actions of Congress to direct day to day procurements in DOD. [15]

DOD and industry complaints of this law ranged from excessive warranty costs to severe problems of warranty administration. [16:S15666] The DOD maintained a go slow approach to implementation. Secretary Taft issued a 90 day general waiver of the warranty requirement on the basis of cost effectiveness. The military services needed time to assess the cost impact of incorporating the requirement into pending contracts. Waivers could be granted by the Service secretaries and defense agency directors with the appropriate authority. The DOD applied the statute as directed, despite industry protests and heavy public and Congressional pressure. [16]

With the realities of applying Section 794, the Senate Armed Services Committee attempted to remedy many of the problems brought on by the 1984 Act. Some of these problems included:

1. What did the definition "other defense equipment" specifically mean? Did this include support equipment as well as the weapon system itself?

2. How much flexibility is authorized in negotiating warranty requirements?

3. Should warranties apply to cost type contracts? [17:35]

Congress passed the amended warranty legislation as a part of the 1985 Defense Appropriations Bill. This amended law revised the 1984 Act in a more workable manner. It included six significant changes: [18:13]

- The definition of "weapon system" and "component" were clarified.

- The Secretary or his delegate was given leeway in deciding on the stated remedies for breach of warranty unless provided in contract.

- Language was added that clearly authorizes the negotiation of specific details of a guaranty including reasonable exclusions, limitations, and duration.

- The Secretary was empowered to reduce the price of any contract to collect the reasonable costs of corrective action undertaken by the United States.

- The guaranty requirements apply only to systems that are in mature full-scale production. This means it applies to all units after the first one-tenth of the eventual total production or the initial production quantity, whichever is less.

- The warranty applied to any design or manufacturing requirement included in a contract amendment.

With the issue of Government Furnished Equipment, (GFE), the contractor would not be responsible for warranting GFE within the weapon system he produces. The contractor is responsible for proper installation of the GFE so as not to invalidate the warranty provided by the manufacturer of the GFE to the Government. [17:36] Examples of this are breaking a warranty seal, losing the associated warranty

paperwork or marking plate, and installing the GFE improperly so as to cause it to fail.

The new law, Section 2403 to Title 10 of the United States Code, directed the DOD to implement warranties on major weapon systems where warranties proved cost effective. This was to be determined by applying a life cycle cost model with and without the warranty. The Department of Defense Federal Acquisition Regulation Supplement (DFARS) Subpart 46.7 provided direct guidance on implementing warranties. In applying the above regulations, confusion arose in DOD over what factors were to be considered in determining whether a warranty is cost effective. Secretary Taft provided the following guidance: [16]

1. In order to facilitate the identification of the cost of the guaranty, the cost of the guaranty shall be set forth either in the contract or in the contracting officer's documentation, supporting the negotiations.

2. There are other factors which must be considered in determining whether the guaranty is cost effective such as any indirect costs to the Government necessary to maintain the guaranty in effect. (Examples--effect on breakout and competitive procurement)

To put the above guidance into action, an all-encompassing cost estimate and analysis must be carefully performed. An inadequate review by the contracting officer may cost the Government much more than what the warranty actually cost.

The Navy seems to have gone one step further than the guidance provided by Secretary Taft. As determined in interviews with key Navy contracting officials, the Navy's unwritten policy on warranties is that the Navy will simply

not pay for warranties regardless of cost. [19] In a competitive environment this would seem easy to do, but in a sole source position it may prove difficult. The Navy's position is that getting the contractor to stand behind his product is a form of an implied warranty and therefore should not cost extra. The Navy will pay for a design or an extended period warranty where the cost could be justified.

The current overall DOD policy on warranties, highlighted in DFAR 46.7702, narrows down three particular areas in which a prime contractor must provide the Government with a written warranty for major weapon systems. These areas include the following: [3:46.7-3]

- Design and manufacturing requirements specifically delineated in the contract, (or any modification to that contract).
- Free from all defects in materials and workmanship at the time of acceptance or delivery as specified in the contract.
- If manufactured in mature full-scale production, conform to the essential performance requirements as delineated in the contract, (or any modification to that contracts).

E. MILITARY EXPERIENCE WITH WARRANTIES

As far back as 1968 with Lear Siegler providing warranties on A4/F4 gyro's to Pratt & Whitney's current warranty package for the Alternate Fighter Engine (AFE) program, warranties were applied in DOD. [8:27, 20:65] Based on a 1979 internal DOD survey, one-third of the 4.1 million types of items in DOD's inventory are covered by

some type of warranty. A number of studies were conducted on the actual benefits of warranties but with varied findings. Three recent uses of warranties indicate inconclusive results. [21:26]

The Air Force estimated that they saved a billion dollars in the AFE based largely on improvements in Pratt & Whitney's F100-220 warranty offer. This estimate was based over a 20 year life cycle. [22:145] It would be interesting to investigate how the Air Force came up with the savings. Did they match savings against costs of administration of warranties?

The Navy has had mixed results with its recent application of warranties. With the Phoenix Missile, the Navy negotiated an unconditional no cost warranty with Hughes Aircraft Co. covering 265 missiles over a three year period. [23:98] Could this no cost warranty be the result of a competitive advantage or the Navy's staunch stand on not paying for warranties?

With the Tomahawk Cruise Missile program, applying Congressionally dictated warranty law for missile hardware cost the Government an additional $340.8 million dollars. [24:81]

Estimates for both savings and additional costs for the above programs are "up-front" estimates. It would appear that any estimates for current warranty applications are extremely premature. Good or bad, new warranty applications

are a radical change in doing business. Careful analysis has to be made because of the numerous variables which have to be taken into account. Declaring $1.0 billion savings or $300 million in additional costs from warranties could be no more than a little political gaming.

Because the Navy currently does not have a data base for tracking warranties, it is difficult to look at the overall Navy warranty picture. The only way to obtain these data is to look at each program individually. Table 2 presents a sampling of warranties now being developed in the Navy.

F. CONTRACTUAL APPLICATION

This section will briefly highlight key points in applying warranties for weapon systems from the Federal Acquisition Regulation (FAR) Subpart 46.7 and DOD FAR Supplement (DFARS) Subpart 46.7. Under the FAR, warranties are not mandatory. If warranties are to be applied, the contracting officer should consider the following factors: [5:46-9]

1. Nature and use of the supplies or services
2. Cost
3. Administration and enforcement
4. Trade practice
5. Reduced requirements (i.e., reducing the Government's contract quality assurance requirements where the warranty provides adequate assurance of an adequate product).

TABLE 2

SELECTED AIRCRAFT WARRANTY REVIEW

Program	Summary of Warranty Duration	Warranty Cost as % of Hardware Either Proposed or negotiated (Note 1)	Length of Warranty Discussions
CH-53	2 years	4.3%	6 months
AH-1W	250 Flight hours for Flight Critical Components Airframe Structure and 3 Pieces of S/C Equipment	15% Total A/C 2.5% for tailored list	3 months
F/A-18	2 years	5%	9 months
E-2C	6 months patent unlimited latent in 86--will go to 24 months patent in 87	NA	NA (took 18 months to settle FY-85)
AV-8B	2 years	12%	8 months
EA-6B	6 months patent unlimited latent in 86--will go to 24 months patent in 87	NA	NA
F-14A	2 years for Critical Performance Guarantees	.1%	6 months
SH-2F	12 months	1.05%	NA
P-3C	Unlimited latent 9 months patent	2.5%	6 months
SH-60F	2 years	2% NTE	NA
SH-60B	2 years	4%	6 months

NA - Not Available NTE - Not to Exceed

TABLE 2 (CONTINUED)

Note 1: These figures reflect an approximation of the program warranty cost even though warrant cost is not a separate contract line item cost.

Source: Interviewee, Naval Air Systems Command

The FAR presents five contract clauses and alternates which may be modified when warranty coverage is appropriate. These clauses include: [5:46-11]

1. Warranty of Supplies of a Noncomplex Nature, FAR 52.246-17
2. Warranty of Supplies of a Complex Nature, FAR 52.246-18
3. Warranty of Systems and Equipment under Performance or Design Criteria, FAR 52.246-19
4. Warranty of Services, FAR 52.246-20
5. Warranty of Construction, FAR 52.246-21

While warranty application may be similar, weapon system warranties under DFARS differ from those under the FAR in two important areas:

1. DOD weapon systems warranties are mandatory unless: a waiver is granted, the contract is a cost-reimbursement type contract, or the unit cost or total procurement cost does not meet the statutory requirements. [3:46.7-2]
2. As a departure from the FAR, the contractor is required to provide warranties on weapon systems he designed and also weapon systems designed or controlled by the Government, if the warranty coverage is cost effective. [4:2]

Contracting Officers in the DOD entering into contracts for the production of a weapon system with a unit weapon system cost of more than $100,000, or the eventual total procurement is in excess of $10,000,000, must include the following warranties:

- Design and Manufacturing
- Materials and Workmanship
- Essential Performance Requirements

Any or all of the above warranties may be waived if the waiver is "in the interests of national defense or if the warranty is not cost effective." [3:46.7-3] Although not a part of this research, it would be interesting to determine how many waivers have been submitted for complete weapon systems or for a particular type of a warranty.

DFARS emphasizes that warranty terms and conditions should be tailored for each application. Chapter IV will show how this tailoring is practiced by comparing different warranty clauses as a case study.

G. CHAPTER SUMMARY

As a backdrop for further discussion on weapon system warranty law implementation, this chapter has presented an explanation of warranties. Primarily, it is a mechanism for shifting risk to the seller for ensuring product quality. With problems of weapon system quality occurring more frequently, Congress directed the DOD to employ warranty coverage where cost-effective. Although the warranty business is not new to DOD, applying it within the context of the new laws was a significant change in its contracting business. The benefits to be gained from employing warranties are numerous, but there are many pitfalls which stand in the way of success for any particular weapon system program.

Chapter III will present how each Service implemented the new warranty laws through Service directives as of 1

July 1986. The focus of Chapter III will show what the Navy has done through its Systems Commands.

III. WARRANTY LAW IMPLEMENTATION

A. CHAPTER OVERVIEW

The purpose of this chapter is to provide a brief overview of warranty procedures as implemented by Air Force, Army, and Navy regulations. Differences between Service regulations are presented in a chart type format. Analysis is concentrated on the Navy draft implementing instruction, SECNAVINST 4330.XX. Discussion continues regarding Navy procedures for implementation flow down through the Navy Systems Commands.

B. SERVICE IMPLEMENTATION

Each Service has a varied background concerning past warranty use. The Air Force was heavily involved with reliability improvement warranties in the early 1970's. The Army has used extensive warranty coverage on vehicles and airframes. The Navy has applied warranties primarily in their airframe and shipbuilding concerns.

With this different warranty experience, each Service implemented or is in the process of implementing Section 2403 of Title 10, United States Code in a different manner. This section will either present a synopsis of those published or draft implementation procedures from each Service.

1. Air Force

The Air Force developed their Warranty Implementation Plan through a two-step process. Major Command maintenance and supply personnel were solicited to provide critical warranty administration problems. Using that input, a joint Air Force Logistics Command and Air Force System Command workgroup was then established to formulate the plan. [25:2]

The Air Force Warranty Administration Plan was implemented on 11 April 1986 and approved by Lieutenant General Leo Marquez, USAF. The purpose of the plan is as follows:

> To establish a system for acquisition and logistics organizations to track and administer fielded systems and equipment covered by contractual warranties, and to provide feedback to the contracting community on the feasibility of specific warranty items. [26:1]

The plan provides some historical Air Force background on warranty use along with emphasis on the establishment of the Product Performance Agreement Center. The requirements of the new warranty law are briefly explained. Terms used throughout the instruction are also described. Two significant terms should be noted--"Warranty Manager" and "Warranty Plan."

The warranty manager is the office accountable and responsible for all warranty related activities. His duties range from providing disposition instructions to monitoring contractor performance. This warranty manager provides a

single face to the customer and contractor concerning warranty matters. [26:4-5]

The warranty plan is a document within the program management sphere which outlines key facets of warranty coverage for a particular weapon system. It is recommended that the warranty plan be "completed and coordinated" before the release of the Request for Proposal, but no definitive requirement exists for it to be in place. [26:5]

The Warranty Administration Plan outlines five major objectives to be accomplished: [26:20-22]

Objective 1--Establish an Interim Warranty Administration System (Near Term)

Objective 2--Automate the Administration Process (Long Term)

Objective 3--Establish Policy Requirements

Objective 4--Establish a Training Program

Objective 5--Develop Packaging, Handling, and Transportation

Objective 1 discusses manual interim procedures for managing warranties. Actions included are marking, tracking, reporting, disposition and material accountability. Major points within this objective include: [26:7-8]

- Markings as of MIL-STD-129 and 130.
- Use of issue exception code B when issuing items from the supply system.
- Warranty duration expressed as calendar days is recommended. If not, the use of an elapsed time indicator should be considered.
- Consideration in warranty duration concerning transportation, storage and redistribution activities.

- Field Level procedures for warranty management.
- System level maintenance orders including an alert to users that the system may be under warranty.
- Disposition instructions.
- Accountability of a returned warranted item is held jointly by the warranty manager and the cognizant Contract Administration Office.
- Warranty manager tasked with monitoring contractor performance of warranty items.

The above interim warranty administration procedures have an implementation date of 1 April 1987. Figure 2, presents a picture of the intended field level procedures.

Objective 2 highlights the fact that to be effective and efficient a warranty administration program must be automated. The use of bar coding is also being considered. Expected implementation of an automated program is in the 1988-1990 time frame. [26:9]

Objectives 3, 4, and 5 are broad strokes of policy requirements. Objective 3 describes regulation and publication updates; Objective 4 describes training program development; Objective 5 defines particular areas of packaging, handling, and transportation which must be addressed in future procedures. [26:9]

The Air Force Warranty Administration Plan presents general policy requirements of what should be accomplished in warranty administration. Specific milestones are identified for those requirements. The appointment of a warranty manager and the documentation of a warranty plan

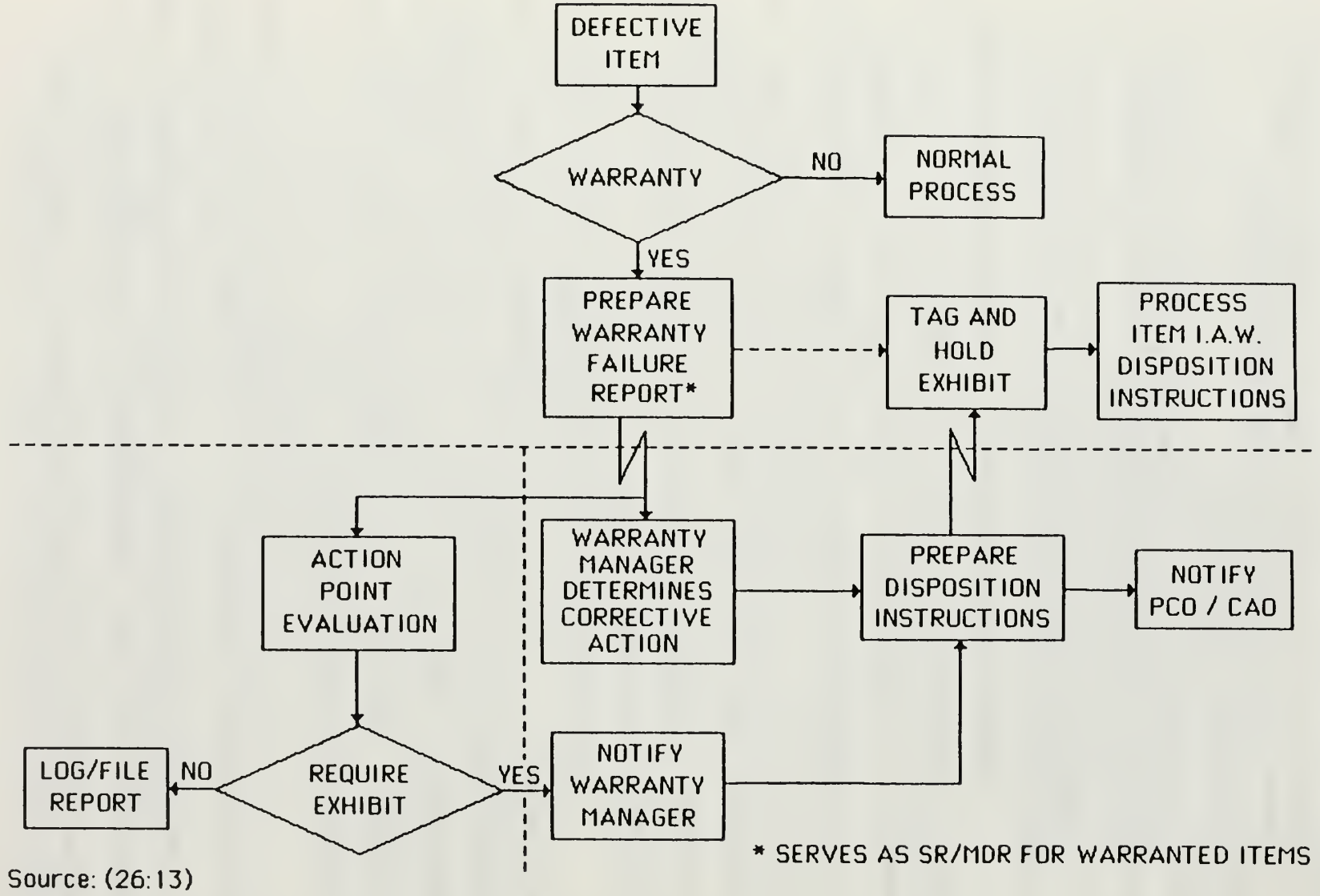


Figure 2. Air Force Interim Warranty Administration

appear as key ingredients for the successful application of warranty coverage. The emphasis on coordination between the warranty manager and the Contract Administration Office is another important factor. This Warranty Administration Plan in a sense lays the foundation for further implementation actions. It directs implementation procedures to be in place in the future.

2. Army

Of the three Services, the Army has the most definitive, published set of warranty procedures to date. Army Regulation AR 700-139, effective 10 April 1986, lays out step-by-step procedures on Army management of warranties. The regulation is broken out into seven chapters: [27:1]

CH1 Introduction
CH2 Responsibilities
CH3 Statutory and Regulatory Requirements
CH4 Warranty Acquisition Policy and Procedures
CH5 Warranty Information
CH6 Warranty Fielding and Execution
CH7 Compliance

Also included is an internal control review checklist for use in cost-effectiveness analysis and payoff assessment. The following discussion attempts to highlight major points in each chapter.

The purpose of the regulation is identified in Chapter One. Warranty coverage is applied to both centrally procured and locally procured items. Centrally procured items are complex, durable, and expensive equipment generally used Army-wide. (For example, M1A Tank or a Blackhawk helicopter). Locally procured items are consumable in nature and used at the organization level. (For example, office supplies or small general use hand tools). [27:3]

Chapter Two defines specific responsibilities for warranty management. Waiver authority for warranty coverage by the Assistant Secretary of the Army (Research, Development, and Acquisition) is explained. The Deputy Chief of Staff for Logistics, (similar to the Commander, Naval Supply Systems Command), has Army Staff responsibility for the Army's Warranty Program. The Material Developer (similar to the Navy Hardware Systems Commands), is the prime implementor and acquisition authority for warranty coverage. They must ensure that warranty coverage can be carried out within the Integrated Logistics Support Plan of a major weapon system development program. A warranty control office/officer (WARCO) is established at each Major Command as a point of contact once the weapon system is deployed. The WARCO performs a number of duties. These include coordinating with the Material Developer concerning warranty execution procedures and informing various activities of

warranty coverage through warranty technical bulletins. [27:3-4]

The statutory and regulatory requirements concerning warranty coverage are outlined in Chapter Three. This section makes particular note of program management warranty documentation. Army review process within a weapon system development program, including review by the Army System Acquisition Review Council, must entail warranty considerations. [27:4]

The primary emphasis of Chapter Four is that each warranty must be tailored to fit the particular equipment with "minimal impact on standard Army logistics procedures." [27:4]

The Army narrows warranties to two basic concepts: Expected Failure Concept and the Failure Free Concept. The Expected Failure Concept acknowledges that any design will include some failures. Any failure above a certain level initiates a warranty claim. The Army in effect terms this concept "systemic defect coverage." If warranty provisions do not include individual item warranties, the failure level is determined through various field reports, such as a Quality Deficiency Report. Under the Failure Free Concept any individual item failure within a given time period requires claim actions. [27:5]

Before any weapon system procurement, the Army requires a formal cost effectiveness analysis as obligated

by regulation. In addition, "warranty assessments" are made throughout the warranty coverage period to further evaluate whether the warranty benefits do indeed outweigh the costs.

Any warranty managed by the Army must include provisions for warranty repairs by the Army. The only remedy authorized for this action is a contract refund or reduction for expenses incurred including transportation. Specific cost elements for refund calculation are presented. [27:6]

Warranty duration is determined by two factors: average elapsed time factor and an operational use factor:

> The average elapsed time factor is the period of time which occurs from the time of contract delivery until the item is placed in operation. (This includes all normal delays). The operational use factor is the period of time in actual operation that will prove the substantive quality of the item and the integrity of the manufacturing process. This period should be between 10 and 25 percent of the expected life and generally not less than 1 calendar year or 1 year of an equivalent usage rate in whatever units are best measured. [27:6]

If there is any instance in which the equipment will not become operational (example - War Reserve Material), the contract price is adjusted in a manner similar to repair refunds, described in the previous paragraph. [27:7]

Warranty marking is laid out in specific detail. In addition to the standard MIL-STD-130 requirements the following minimum information must be included:

"WARRANTY ITEM"
"WTB XXXXX" (Unique number)
"EXPIRES XX/XX" (Unique date/rate)

Bar coding of this information is recommended, but currently not required. Any shipping and release documents, such as a DD1348-1, must have information identifying the warranty in the remarks section. [27:7]

A central collection agency is designated for managing a warranty data base. Detailed data elements are highlighted. The information in the data base is shared by both the Material Developers and the Major Commands for analyzing warranties. This data base allows for a twenty-four hour query response on specific warranty data requests. The central collection agency also publishes various warranty related reports and informational listings such as a WARCO address and indices of warranty items. [27:8]

Chapters six and seven describe warranty fielding, execution and compliance procedures. These procedures must be implemented in such a manner that the item is supported in the same manner during the warranty coverage and after warranty expiration. This involves Army logistical support systems, uniform administrative procedures, and user visibility. [27:8]

In summary, AR 700-139 stipulates explicit procedures for warranty management. These procedures are published and in place. The regulation emphasizes tailored warranty coverage for maximum cost effectiveness. The coverage must be user friendly if required or invisible to

the field level user. Responsibility is centered on specific activities. Information is available through warranty technical bulletins and the central collection agency for effective management. A mechanism is provided through warranty assessment procedures for ensuring that the warranty is doing what it is supposed to and that the warranty is truly cost effective. These procedures appear detailed enough to provide consistency from the Army Staff down to the user level. The Army warranty system is characterized by centralized authority and responsibility.

3. Navy

In September 1985, the Assistant Secretary of the Navy (Shipbuilding and Logistics), ASN (S&L), established a Navy Warranty Ad Hoc Group from representatives of the Navy Systems Commands. This group was assigned to do the following: [28]

- Establish essential performance requirements criteria.
- Establish procedures for warranty field administration.
- Determine contractual requirements to be placed on contractors, i.e. segregation of historical warranty cost data.

The ASN (S&L) office was specifically tasked to develop overall Navy policy on administration of warranties in the field.

In late November 1985, the first draft of proposed SECNAVINST 4330.XX, Navy Warranty Program, was submitted to appropriate Navy Commands for review and comment. The most

significant feedback on the proposed instruction centered on the requirement that "warranties should generally be obtained at no additional cost to the Navy." Five of the activities responding highlighted an apparent inconsistency. Although the proposed instruction required "no cost" warranties, it also specified identification of any price that is paid for a warranty. Navy upper management unofficial policy was that the Navy should not have to pay an additional amount of money for a particular level of quality that the contractor should be providing in the first place. The warranty cost statement was eventually revised in further drafts. [29:8]

This treatment of warranty cost and associated risk to the contractor are the prime stumbling blocks in publishing an official Navy policy on warranties. The following review will concentrate on the draft SECNAVINST 4330.XX as it stood on 1 July 1986.

The purpose of SECNAVINST 4330.XX is to provide overall Navy policy relating to warranty requirements of the new warranty law and DFARS Subpart 46.7. These regulation requirements are briefly outlined and reiterated. The following major points of the requirements section of the instruction are summarized below: [29]

a. Emphasis is placed on warranty cost effectiveness by performing a formal cost benefit analysis and including it in the contract file. A Navy Warranty Cost-Benefit Analysis Policy Guide is included as an enclosure to the instruction.

b. Essential performance requirements are defined and addressed. The key to essential performance requirements in warranty development is that they must be "measurable and verifiable by the contractor and the Government." Auditable records relating to warranty risk/cost comparisons are to be maintained. The first contract for mature full-scale production must document essential performance requirements. Acquisition plans for major weapon systems must include warranty strategy.

c. Warranted items must be marked with this minimum information:

- Item identification number or part number

- Contract number

- "Indication" warranty applies

- Manufacturer

- Warranty expiration date

- Notification of what actions void warranty

d. Navy Systems Commands are to develop some type of warranty information system for notification of warranty failures, disposition instructions, and a failed unit return system. The main method of carrying out the above actions is through the Quality Deficiency Report system (SF368). It is stressed that warranties should not be "burdensome" to Navy and Marine users. Within this warranty information system, undetermined warranty administration points of contact are to collect the following types of warranty data:

- numbers of replacement/repairs.

- numbers and dollar value of claims made.

- numbers and dollar value of claims successfully recovered.

The above data and also contract clauses and solicitations for warranties shall be provided to the Joint Service Data Base, Product Performance Agreement Center (PPAC), at Wright-Patterson AFB, Ohio. Requests for assistance from PPAC in warranty use and development are encouraged.

e. Warranty duration is defined as being of a "reasonable" length. The type of defects and failure that may occur and also possible storage time should be examined.

The next section of SECNAVINST 4330.XX discusses implementation by the Hardware Systems Commands. Basically, it is restatement on how the previous section warranty requirements are to be dealt with contractually. The many types of data required from the contractor for warranty administration are specified. The following elements must be in each warranty section of a major weapon system contract:

- Warranty requirements covering:
    1) Conformance to design and manufacturing requirements
    2) Freedom from defects in materials and workmanship
    3) Conformance to essential performance requirements
- Associated warranty cost data
- Undefined data to determine warranty effectiveness
- Marking requirements
- Warranty duration
- Turnaround time
- Transportation cost
- Government repair option

This section also directs the establishment of warranty administration points of contact with additional elements of warranty information to be maintained. These

points of contact are not defined to any particular activity. [29]

The proposed SECNAVINST 4330.XX presents a broad policy framework for Navy warranty management. It allows for liberal interpretation of implementation requirements, particularly in the area of a warranty management information system. This instruction, like those of the Air Force and Army, maintains an accent on cost effectiveness and user visibility.

C. COMPARISON OF SERVICES REGULATIONS

1. Differences

This section will present an examination of Air Force, Army and Navy warranty procedures. This is accomplished by identifying major warranty issues and presenting how each Service regulation accommodated those issues. Table 3 displays a more readable format to make these comparisons.

The following is a brief discussion on the Service treatment of various warranty issues outlined in Table 3.

a. Overall Policy Responsibility

The Air Force and Army assign military positions the duty of providing warranty policy guidance. The Navy maintains civilian leadership for this policy at a different organizational level. Because of the organization differences within each service, it is difficult to make any noteworthy comparisons.

TABLE 3

WARRANTY ISSUES IN SERVICE IMPLEMENTATION PROCEDURES

	Air Force	Army	Navy
Overall Policy Responsibility	- HQ USAF/LEY/RDC - Draft AFR 800-XX Jan 1987	- Deputy Chief of Staff for Logistics	- Asst Secretary of the Navy (Shipbuilding and Logistics) (ASN (S&L))
Warranted System Responsibility	- normally assigned within AFSC Product Division or AFLC Air Logistics Center	- Material Developers (MAT DEV)	- Systems Command
Warranty types Defined	- Group (Fleet) Warranty; applies to all delivered items collectively; little impact on operations. - Item warranty; individual item repair and replacement.	- Expected Failure (System Defect Coverage) - Failure Free (Individual Item)	- Conformance to design and manufacturing requirements - Freedom from defects in material and workmanship - Conformance to essential performance requirements
Operational Review of Warranty Effectiveness	- warranty manager/CAO surveillance of contractor performance	- Periodic or annual warranty assessment by Material Developer after item delivered	- Biannual summarized report to ASN (S&L)
Warranty Management Information System	- PPAC - Technical Order 00-35-5 (to be published in May 1987), will address specifics	- Central Collection Agency - Warranty Technical Bulletin - Index of Warranty items - 24 hr. response to data requested	- "Fully coordinated customer/user notification system" to be developed by Systems Command
Warranty Reporting or Claim Format	- Warranty Failure Report - Technical Order 00-35-5	- Defined in the Army Maintenance Management System (TAMMS)	- Quality Deficiency Report (SF 368)
Failed Unit Return System	- Failed unit held until disposition instructions received from warranty manager	- Normal Retrograde	- To be developed by Systems Commands

TABLE 3 (CONTINUED)

	Air Force	Army	Navy
Documentation Requirements in Weapon System Development Plans	- Warranty Plan developed prior to release of RFP	- Integrated Logistics Support Plan - Acquisition Plan	- Acquisition Plan
Cost/Benefit Analysis	- Defined - Included in warranty plan	- Required - Procedures determined by MAT DEV	- Required in contract file - Life cycle costs - Example technique provided
Problem Resolution Mechanism	- PPAC	- 24 hr. hotline maintained by MAT DEV	- Not addressed
Essential Performance Requirement	- Defined	- Not addressed	- Identified in program planning and decision documentation - Approved by decision authority appropriate for Acquisition Category of specific program - "measureable and verifiable"
Marking	- MIL-STD-129 - MIL-STD-130 - "conditions of warranty specifically stated"	- MIL-STD-130 - "Warranty Item" "WTB XXXXX" "Expires XX/XX" - Shipping and release documentation - Computer Program visual display	- Part number - Contract number - "Indication" Warranty applies - Manufacturer - Expiration date - Notification of what actions void warranty
Turn Around Time (TAT)	- TAT must be "guaranteed" to ensure spares available - Defined	- "Not any less responsive than normal Army maintenance methods to sustain readiness" - Defined in terms of time in warranty contract provision	- Stated in contract - Liquidated damages if not met

TABLE 3 (CONTINUED)

	Air Force	Army	Navy
Repair/Corrective Action Responsibilities and Remedies	- To be published in Technical Order 00-35-5, (May 1987) - "Warranty clause not to limit Government's right under any other contract provision."	- Must include authorization for Army Repair - Contract adjustment - Cost Element calculation	- Government repair option - Contract adjustment
Duration	- Fixed calendar date if possible, if not use elapse time indicator - No longer than required to identify defects and verify essential performance requirements - Storage consideration	- 10% - 25% of expected life - Generally not less than 1 year or 1 year of equivalent usage rate - Measureable - Storage consideration	- Consideration given to operating characteristics of item - Storage consideration
Tracking	- Defined - Serially numbered if possible - Example of Comprehensive Engine Management System	- Claim action provided to MAT DEV through TAMMS - Items identified through warranty technical bulletin - "Must be compatible with standard Army support system"	- To be established by System Command - Quality Deficiency Reporting System

b. Warranty System Responsibility

Each Service essentially retains this responsibility with the organization producing and developing the weapon system. This facilitates program management review and responsibility for the weapon system.

c. Warranty Types Defined

Although using different terminology, the Air Force and Army align warranties into two categories: 1) An individual piece of equipment warranty, and 2) An overall system warranty. The Navy delineates warranties within the context of the definitions provided in the warranty legislation.

d. Operational Review of Warranty Effectiveness

Each Service maintains somewhat different review procedures. While the Air Force and Army lay out specific procedures and elements for review, the Navy only provides for summarized reports to the policy organization. The researcher observes that it is necessary to establish a systematic and routine review procedure for evaluating warranty effectiveness.

e. Warranty Management Information System

One of the primary keys to warranty management is a comprehensive management information system (MIS). The Services have not fully developed their warranty MIS. The Air Force and Army are in the process of laying the groundwork for this. The Air Force has established PPAC.

The Army has been providing warranty technical bulletins, warranty indexes, and maintaining a database. The Navy directs the Systems Commands to develope warranty MIS.

f. Warranty Claim Reporting or Claim Format

Maintenance directives outline these requirements in Air Force and Army. Navy supply manuals (for example--NAVSUP P-485, Afloat Supply Procedures QDR system) describe reporting requirements.

g. Failed Unit Return System

The Navy has yet to publish procedures for their failed unit return system. The Army's method appears as the least disruptive to standard procedures. This promotes ease of handling at the user level.

h. Documentation Requirements in Weapon System Development Plans

The Acquisition Plan is the common element between Services for incorporating warranties in program documentation. The Army additionally requires documentation in the Integrated Logistics Support Plan (ILSP). This is a rational decision because of the effect warranties have on developing a maintenance plan. The maintenance plan is a major design and cost driver in the ILSP.

i. Cost/Benefit Analysis

Each Service requires a warranty cost/benefit analysis either included in the warranty plan or contract file. The Navy has gone one step further by including a

warranty cost/benefit outline and guidance document with SECNAVINST 4330.XX.

j. Problem Resolution Mechanism

Warranty coverage is a sharp change in the business manner of developing and acquiring weapon systems. Questions are bound to arise with both contracting personnel and the field level user. The Air Force and Army have procedures or organizations in place to handle problems. This area was not addressed in the Navy implementing instructions. Long range degradation of warranty effectiveness may result because of this.

k. Essential Performance Requirements

The literature reviewed for this study emphasized the defining essential performance requirements in developing warranties. The Navy has created extensive procedures for ensuring the emphasis is not minimized. The Air Force and Army briefly touch on this topic in their implementing instructions.

l. Marking

Each Service requires various warranty elements to be included in warranty marking labels. There is little consistency between Services. The Army requirements of warranty marking, shipping and release documentation and computer program visual displays should be adopted by both the Air Force and Navy.

m. Turnaround Time (TAT)

Within each Service procedures, TAT is defined and contractually required. The Air Force and Army underscore the importance of dependable TAT by either ensuring TAT is "guaranteed" or not any less responsive than normal maintenance methods.

n. Repair/Corrective Action Responsibilities and Remedies

The Services include various remedy options within their implementing instructions. The Army directs that it must always include the option for Army repair. In calculating costs for the equitable adjustment option, the Army provides specific cost elements to be used for continuity.

o. Duration

The concepts used for determining warranty duration appear different between Services. The Air Force's idea of fixing duration "no longer than requires to identify defects . . ." differs from the Army and Navy. The Army quantifies percentages of expected weapon system life. The Navy, which as shown in the next chapter, generally goes with a standard time frame. All Services highlight storage considerations in warranty duration.

p. Tracking

As with previous warranty issues, the Army lays out detailed procedures for handling tracking. The Air Force only defines tracking. The Navy procedures make

reference to the Quality Deficiency Reporting System, but leaves the specifics to the Systems Commands.

2. Analysis

As illustrated in the preceding section, each Service approached major warranty issues with largely different wording. As opposed to the Army's and Air Forces's centralized responsibility and detailed procedures of warranty management, the Navy has left many of the specifics to the Systems Commands for implementation. The following issues highlight the analysis of those Navy implementation procedures with Air Force and Army procedures as background.

a. Marine Corps Involvement

Although the Marine Corps looks at itself as being separated from the Navy, they share many of the same logistics channels and procedures. SECNAVINST 4330.XX tasks the Marine Corps with developing their own policies and procedures for processing warranty claims. Not all Marine Corps equipment is procured through strictly Marine Corps procurement activities. The Navy Plant Representative Offices often provide contract administration functions. Why not standardize the claims procedures between the Navy and Marine Corps for ease of processing? Which claims procedures does a Marine Corp activity use with equipment procured jointly with the Army?

b. Cost-Benefit Analysis

How do you perform a cost-benefit analysis when the unofficial Navy policy is that warranties should not cost extra? The Navy Warranty Cost-Benefit Analysis Policy Guide provides only general elements to follow. It also states that various checklists and computer procedures have been developed for assistance. Navy Systems Command people interviewed knew little, if anything, of any cost-benefit model or computer systems available. With few knowing how to perform a cost-benefit analysis, it is either not being done at all or only being performed in a cursory manner, as can be expected.

c. Joint Service Data Base, Product Performance Agreement Center (PPAC)

Warranty use and claim data, contract clauses and solicitations are required to be provided to PPAC. As of July 1986 no data have been provided to PPAC by the Navy. Only the Naval Air Systems Command (NAVAIR) has contacted or investigated the use of PPAC. The idea of a Joint Service Data Base sounds fine in theory, but in reality it may prove difficult to use, primarily because of location. This could also be why the three Services have not completed an agreement as to funding PPAC as a Joint Service Activity. This researcher observes that the Navy might be better off concentrating its efforts in developing their own warranty expertise points of contact and data base.

d. Marking

The instruction provides minimum data elements for marking. To avoid confusion at the user level and make the user more aware of a warranted item, a standardized format similar to what the Army has done may be more conducive for processing. The maintenance man only has to know one format. A question arises on joint Service procurement programs. Which Service marking procedures do you use? A new military standard covering all three Services for warranty marking could reduce problems.

e. Customer/user notification system

From the instruction it is not clear whether or not each Systems Command is to develop their own system. One could only imagine the problems for a maintenance activity having to deal with three or more different reporting systems. It would appear to be more effective to develop one reporting system which crosses Command lines. The use of a SF368 (Quality Deficiency Report) is only the first step of the system. Although the instruction emphasizes that warranties should not be "burdensome" to the Fleet, it does require additional management controls to be implemented at the user level.

f. Warranty Administration Points of Contact (POC)

These warranty POC's are mentioned throughout the instruction. The Systems Commands are tasked with establishing these Warranty POC's at Navy activities as

appropriate. Does this allow the Systems Commands to push warranty management responsibility further down the chain of command? What defines a Navy activity as appropriate? Because the warranty POC's hold a key position in overall Navy administration of warranties, it would seem to be more effective, from a management point of view, to be more precise in establishing the warranty POC's. The user could be faced with a hodgepodge of warranty activities when trying to resolve a problem.

g. Warranty Effectiveness

A front end analysis is required to determine warranty cost effectiveness, but there is no established mechanism evaluating warranty effectiveness once the warranty is "operational." The data for assessment are required contractually, and summarized reports are forwarded ASN (S&L). Is this enough to ensure a routine appraisal of a particular warranty program? The instruction directs management controls to ensure that the user carries out proper warranty procedures. Why not institute some type of control to ensure an effectiveness review is enacted?

h. Program Planning Documentation

Acquisition plans must now address the planned use of warranties. When questioned regarding the existence of provisions for warranties in acquisition plans, interviewees at the Systems Commands responded that a warranty is called for in the plan but no further

elaboration of its features are identified. Incorporating a warranty plan in the Integrated Logistics Support Plan (ILSP) early on in program development, forces a more thorough review. The maintenance planning concept coming out of the ILSP is made more realistic through warranty considerations.

i. The following minor points are highlighted:

1) How do maintenance regulations, such as the Preventive Maintenance System incorporate warranties?

2) What cost elements are involved with contract adjustments of the Government options to repair the warranted item? Should this repair option be mandatory to support readiness?

3) Are Navy activities being provided additional funding to cover warranty administration functions? For example, in a receiving activity such as Naval Supply Center, Norfolk, are work measurement computations to be adjusted to incorporate the added function of verifying warranty applicability to repairables?

In summary it has been over eighteen months since the revised warranty legislation was passed by Congress. The Systems Commands have been warranting weapon systems as required by law, but the Navy has not yet initiated policy concerning implementing procedures. In effect, the Hardware Systems Commands keep pumping out warranted equipment, but the procedures for managing the warranties are not in place. The draft instruction, SECNAVINST 4330.XX, will establish those procedures for the Systems Commands to implement. From this researcher's view, those general procedures should be made in detail. With each Systems Command left to its own implementation, the

user in the field may be faced with a variety of procedures for warranty management. The impact of warranties at the Fleet level is far too great to add additional confusion with different procedures. Why not publish SECNAVINST 4330.XX without its controversial parts, so that at least the Systems Commands have a basis upon which to work? The instruction could be amended later to accommodate any policy initiative changes.

D. NAVY SYSTEMS COMMAND IMPLEMENTATION

As each Service has approached warranty implementation differently, each Navy Systems Command, in meeting the requirements of the law, has used different methods in accomplishing warranty management. This section will look at the Naval Sea Systems Command (NAVSEA), Naval Air Systems Command (NAVAIR), Space and Naval Warfare Systems Command (SPAWAR), and the Naval Supply Systems Commands (NAVSUP) actions of implementation as a logical progression from SECNAVINST 4330.XX, which was outlined in the preceding section.

1. Naval Sea Systems Command (NAVSEA)

In implementing the new warranty legislation NAVSEA 02, (Contracts), and the NAVSEA legal counsel generated two new generic warranty contract clauses as models for compliance to the legislation. These contract clauses are titled the "NAVSEA Standard Shipbuilding Warranty Clause" and the "NAVSEA Baseline Weapon System Clause." A tailored

version of these warranty clauses is included in every major weapon system contract let by NAVSEA. Each acquisition plan must address the planned use of warranties and is verified through NAVSEA 90, (Acquisition Planning and Appraisal). Figure 3 is a summarized check list developed by NAVSEA which identifies the "theoretical" items that should be included in each NAVSEA warranty contract clause.

1. Definition of Terms
2. Performance Requirements
3. Duration
    a. Guarantee Period
    b. Exceptions and Conditions
4. Marking
5. Contractor Obligations
    a. Contractor's Warranty Coverage
    b. Third Party Clause
6. Notification of Failure
7. Failure Verification
8. Remedies
    a. Repair Options
    b. Transportation
    c. Replacement Parts
    d. Turnaround Time
    e. Contractor's Rights to Remedies
    f. Downtime Adjustments to Guarantee Period
    g. Credits
    h. Liquidate Damages
9. Additional Clauses
    a. Government Furnished Property
    b. Foreign Military Sales
    c. Second Source Clause
10. Additional Government Rights
11. Cost Tracking
12. Disputes

Source: [30]

Figure 3. NAVSEA Warranty Checklist

In July 1985, NAVSEA 90 published a warranty guide entitled, "NAVSEA ACQUISITION PROGRAM CONTRACT WARRANTY GUIDE", for use by contracting and technical personnel. The Guide is outlined in six sections: [31]

Section I: Basic Definitions and Requirements

Section II: Contract and Warranties

Section III: Costs and Cost/Benefit Analysis

Section IV: Waivers

Section V: Examples of Warranties

Section VI: Administration of Warranties

Each section is further broken down into a question and answer type format. The questions are general in nature with supplemental information and examples provided with the answers. The Guide is an excellent desk top reference, but cannot supplant formal procedures.

In March 1986, NAVSEA issued a contract to Techmatics, Inc. to perform a two year study in developing a warranty management information system. This system will be designed to provide the following capabilities: [30]

- identify, track, administer, and execute warranty provisions in NAVSEA contracts.
- evaluate the cost benefits and technical worth of warranty provisions over the life of warranties.
- to make judgments and decisions regarding well or poorly structured warranty provisions based on experience data.

Once implemented, this system should provide excellent visibility of all NAVSEA warranties. Currently,

there is no way to identify individual warranties short of going to the specific program or contract file.

NAVSEA is waiting for SECNAVINST 4330.XX to be published before issuing any detailed NAVSEA instructions on warranties. The only necessity now is to ensure that contract clauses meet the requirements of DFARS Subpart 46.7. The shipbuilding business of NAVSEA has felt minimal impact on their warranty management.

2. Naval Air Systems Command (NAVAIR)

NAVAIR's theme throughout its warranty management plans and policies is to ensure the contractor "stands behind his product" and that this responsibility follows the product down to the user level. [32:2-6] This quality responsibility theme extends back ten years to the use of material and workmanship warranties used on aircraft engines. In 1982 performance requirements were also added to engine warranties. These performance warranties included the TF30 Low Cycle Fatigue Life warranty and the F404 performance specification warranty. [33]

Within the aircraft engine world, NAVAIR was a key contributor to the publication in 1984 of a Joint Engine Warranty Development Guide (For Military Aircraft Turbine Engines). This guide presents a comprehensive reference in applying engine warranties. [2]

Although NAVAIR maintained considerable experience with warranties by 1985, problems in warranty management persisted. These problems included: [33]

- Lack of overall organizational procedures and measures of warranty effectiveness.
- Inadequate internal communication on warranties.
- Training and publications not incorporating warranty use and development.

These problems led to increased dependency on the contractor which invariably reduced the effectiveness of the warranty. [33]

Similar to the NAVSEA Warranty Guide, NAVAIR 05 published a "NAVAL AIR SYSTEMS COMMAND GUIDELINES FOR APPLICATION OF WEAPON SYSTEM PROCUREMENT WARRANTIES" in July 1985. Unlike the NAVSEA Warranty Guide, the NAVAIR Warranty Guide is much more detailed. It lays out specific requirements from warranty planning and evaluation factors to sample warranty clauses and contract terms. Like the NAVSEA Warranty Guide, the NAVAIR Warranty Guide is only a reference publication and not an authoritative document.

In December 1985 NAVAIR became the first Systems Command to publish an official instruction, NAVAIRINST 13070.7, which addresses the new warranty legislation. The instruction outlines overall NAVAIR policy in complying with warranty requirements. It stipulates areas of responsibilities for warranty management within NAVAIR, NAVAIR Field Activities and Inventory Control Points and

also the Naval Aviation Logistics Center. For example, the instruction directs NAVAIR 04 to "establish an effective Fleet data feedback system to support NAVAIR warranty administration," but the instruction does not mandate when this action should be done or how it should be done. [34]

In developing warranty marking requirements NAVAIR solicited inputs from the Fleet, Naval Plant Representative Offices, and the Naval Supply Systems Command (NAVSUP). The following elements are required as minimum: [35]

- "WARRANTED ITEM"
- Contract number of procurement
- Warranty expiration date
- Where to ship the item while under warranty

The procedures differentiate marking requirements between contractor furnished equipment and Government furnished equipment. The procedures also delineate what items to mark. For example, designated repairables which can be replaced at the organizational level of maintenance should be marked individually. Major end items such as aircraft must have warranty provisions documented in the Miscellaneous History Record (OPNAV 4790/25A).

In developing a warranty reporting system and problem resolution mechanism, NAVAIR is investigating two techniques: (1) A closed loop Quality Deficiency Report (QDR--SF368) System and (2) Use of contract Warranty

Assessment Boards made up of members from the contractor and NAVAIR.

The Quality Deficiency Report (QDR) System involves warranty violations which do not require corrective action on a one-for-one basis. This approach is similar to the Army's method of managing warranties through system wide failure trends. It involves the following steps: [36]

- All warranted items: warranty cost and disposition information provided in QDR.
- Maintain active data for QDR warranted items.
- Monthly warranty efficiency reporting.
- Warranty item list and warranty provisions reporting.

Warranty Assessment Boards have been established contractually for the HARM and Sparrow missile programs. These Warranty Assessment Boards are made up of technical and contracting personnel from the Government and the contractors. The Boards are required to meet quarterly to review field operational data for each particular program to determine compliance or corrective actions associated with the warranty clause of the contract. The Sparrow Warranty Assessment Board has been used sparingly, but the HARM Warranty Assessment Board, established in December 1984, has had considerable involvement.

3. Space and Naval Warfare Systems Command (SPAWAR)

SPAWAR's approach in implementing the new warranty is similar to that of NAVAIR and NAVSEA with the development

of generic warranty clauses. Professional seminars for educating SPAWAR personnel on the implications of warranties have been enacted. Unlike NAVAIR and NAVSEA, SPAWAR has made no concentrated effort in generating written interim warranty procedures or warranty guides. SPAWAR has chosen to wait for the publication of SECNAVINST 4330.XX before publishing any formal instructions. This could be attributable to the types of equipment SPAWAR buys and the dollar amounts involved as compared to NAVAIR and NAVSEA. In investigating various warranty concepts, SPAWAR has sponsored theoretical research on commercial warranties in the electronics industry for possible military applications.

4. Naval Supply Systems Command (NAVSUP)

It could be argued that NAVSUP does not purchase major weapon systems within the context of the new warranty legislation. Instead, NAVSUP purchases subassemblies or particular components such as pump motors, valves or circuit cards. It has been NAVSUP policy that the other Systems Commands advise NAVSUP when it buys equipment requiring warranty coverage for the Systems Commands. [37]

The Aviation Supply Office, (ASO), with its past experience in obtaining supply warranties on aviation parts, was tasked in July 1985 to develop recommended NAVSUP policy on warranties. [37]

The following points outline key issues on the draft NAVSUP Instruction 4330.XX as it stood June 1986. [38]

- Definition of NAVSUP, Inventory Control Point, (ICP) Hardware Systems Command, and Field Level responsibilities in warranties.

- Establishment of a Warranty Manager at NAVSUP, ICP's and Navy Supply Centers.

- Emphasis on coordination with Hardware Systems Commands in maintaining warranty requirements on equipment supported by the ICP's.

- Establishment of warranty acquisition and administrative procedures by ICP's.

- Direction to the Hardware Systems Commands to establish warranty management information systems. Specific data elements are also described.

- Warranty requirements must operate standard Navy logistics functions including storage, replacement part support, and disposal/retrograde return system.

Enclosures to NAVSUP Instruction 4330.XX present general supply support requirements which have not been fully developed. These requirements appear to be modeled after Army warranty procedures. Not yet mentioned in the instruction is how warranties will affect supply systems inventory models.

E. ANALYSIS OF SYSTEMS COMMAND IMPLEMENTATION

Each Systems Command has gone in different directions in implementing new warranty requirements. This seemingly uncoordinated approach is characteristic of what the Services also have accomplished as described in previous sections. Redundancy in Systems Commands' actions waste assets. An example of this is the establishment of possibly three different warranty management information systems. If SECNAVINST 4330.XX was published and was more definitive in

requirements, these problems might not appear. If the Navy's warranty procedures are not to be "burdensome" to the Fleet, the Systems Commands must integrate their warranty management procedures to present a "single face" to the user.

Many of the people interviewed during this research were working on warranty procedures as a collateral duty. This may account for the long length of time the warranty procedures are in development. Establishing a dedicated staff to warranty management may spur warranty management development. The Army has over a hundred people assigned at the Staff level totally dedicated to warranty control.

Of the Systems Commands procedures or implementation efforts reviewed, none took into consideration the additional workload involved with warranty administration. For example, if the QDR system is used for reporting warranties, what will be the impact at contract administration offices?

The warranty assessment boards provided for in the HARM and Sparrow contracts appear an excellent means for resolving warranty problems between the Government and contractor. Can a Systems Command afford to have a warranty assessment board for every major weapon system it buys? What warranty problem resolution mechanism is afforded to the Fleet user? Fleet maintenance activities operate on a twenty four hour a day basis around the world, and timely

response to problems is required to sustain readiness. If a warranty problem solution avenue is not open to maintenance personnel, the chances increase that the warranty may be voided.

F. CHAPTER SUMMARY

This chapter summarizes warranty implementation procedures of the Air Force, Army, and Navy. Differences between the Service procedures were described. Analysis concentrated on the Navy draft procedures. Discussion then moved on to Navy Systems Command implementation efforts. These actions ranged from a wait-and-see attitude by SPAWAR, to NAVAIR's in-depth warranty guide and warranty assessment boards. Systems Commands' efforts appear uncoordinated between each other. Warranty management cuts across Command lines. To be integrated, warranty management procedures need to be directed from above. An uncoordinated approach will ultimately be a burden on the Fleet. Readiness may suffer and any benefits gained from warranties may be lost.

Chapter IV presents in a case study format the compilation of warranty clauses, as the result of the warranty management actions of a Navy Systems Command.

IV. KEY ISSUES IN NAVY WARRANTY CONTRACT CLAUSES

A. CHAPTER OVERVIEW

Using a modified case study approach, this chapter shows how various elements of a warranty contract clause are put together under the guidance of Service implementation procedures brought out in Chapter III. This modified case study approach involves a comparative analysis between the contract elements of five warranty contract clauses. The primary purpose of the chapter is to underscore the important variables or factors of a warranty contract clause as analyzed through the case study format. Contract clauses are used from the following programs: HARM, SPARROW, SIDEWINDER, TOMAHAWK, and a commercial warranty for communications spacecraft from Hughes Aircraft Company. These particular programs were chosen, based on recommendations received from contracting and technical people familiar with warranty coverage. The communications spacecraft warranty is included to demonstrate what a commercial warranty looks like. It is equipment similar to missiles, in that once it is launched it is seldom recovered.

B. PROGRAM BACKGROUND

The following is a brief description of each program. This information is presented to illustrate the maturity of

the program, complexity of the equipment, and contractors involved.

1. HARM (AGM-88)

The HARM missile is a high-speed, anti-radiation missile. This air-to-ground missile is used against land and sea-based radar emitters from enemy radar. It proved very successful in the Libyan air strike in April 1986. The HARM is now used with Navy A-7E, F/A 18A and Air Force F-4G aircraft. [39:9]

Texas Instruments, Inc. is the systems integrator and also produces the missile seeker, control section, wings and fins. Other contractors produce the warhead, rocket motor, and fuzing. [40:189]

The HARM weapon system began as a joint Navy-Air Force program in June 1972. The Navy maintained lead direction of the program. Texas Instruments Inc. won the development contract in 1974, the initial production contract in 1981, and full production contract in 1983. Originally, the Navy wanted dual-source procurement, but the Defense System Acquisition Review Council (DSARC) directed a sole-source program with Texas Instruments. Although the Navy was blunted in its desire for competitive procurement, the threat of competition reduced negotiated program production costs by approximately three percent. One of those cost reducing techniques was a "no cost" warranty. [39:10]

Equal quantities of missiles are budgeted for the Navy and Air Force. The following actual/projected procurement quantities and dollar values are presented: [40:189]

YR	QTY	Dollar Value
1984	698	$379.2 million
1985	1,559	$589.5 million
1986	2,619	$752.0 million
1987	3,706	$930.8 million

2. SPARROW (AIM-7)

The Sparrow (AIM-7F) is a "medium-range, all-weather, all-aspect, semi-active guided missile." [40:205]. It has been produced by Raytheon in different versions since 1956. The initial FY-72 production contract for the Sparrow (AIM-7F) was won by Raytheon with General Dynamics established as a second source in FY-74. With the FY-77 buy, dual-source competition was started. Out of a total of four split-buy competitions, Raytheon won three. [41:31]

The AIM/RIM-7M version of the Sparrow is similar to the AIM-7F version, but with improved performance and the capability to be used with a NATO Sea Sparrow launcher. The AIM/RIM-7M is in full rate production by Raytheon after a competitive flyoff with General Dynamics. Budgeted and projected procurement plans entail over 14,000 AIM/RIM-7M missiles for the Navy and Air Force with deliveries beginning in 1982. [40:205]

3. SIDEWINDER (AIM-9)

The AIM-9 family of air-to-air missiles was originally developed in the 1950's, with Naval Weapons Center, China Lake, providing technical direction. It is "a supersonic, air launched, rocket-propelled, infrared (IR) guided missile designed to detect, track and destroy aircraft." [42:16]

The current production version of the SIDEWINDER is the AIM-9M. The Navy is the lead service on this joint Navy/Air Force production program. It is made up of seven primary units. The Guidance Control Section (GCS) and the Reduced Smoke Rocket Motor (RSRM) were the components modified with the newer version. The other five components, in production since 1976, remained the same. [43:1]

Raytheon won the original GCS development contract in FY-77 and a follow on production contract in FY-81. Ford Aerospace was incorporated as a second source in FY-82. Under the dual source mobilization base concept both Ford Aerospace and Raytheon received competitive awards in FY-83 through FY-85. [43:5]

Thiokol Corp. won the original RSRM development contract in FY-78 and a follow on production contract in FY-81. Hercules-McGregor was incorporated as a second source in FY-82 also under the dual source mobilization base concept. [43:5]

The Navy is allocated a larger percentage of missiles than the Air Force and Foreign Military Sales. The following actual/projected procurement quantities and dollar values are presented: [40:205, 43:6]

YR	QTY	Dollar Value
1985	1,000	$71.2 million
1986	4,557	$197.6 million
1987	1,873	$99.1 million
1988	1,282	$68.1 million
1989	600	$40.3 million
1990	600	$42.0 million

4. TOMAHAWK (BGM-109)

The Tomahawk is a $2.5 million subsonic cruise missile. It comes in a ground-launch variant (GLCM) and a ship launch variant (SLCM). The Tomahawk can carry either nuclear or conventional warheads. The Joint Cruise Missile Project Office (JCMPO) was established in 1977 for managing Tomahawk development with the Navy as the lead Service. [44:152]

General Dynamics, Convair division, was the original developer and producer of the Tomahawk. In 1982, JCMPO awarded McDonnell Douglas and General Dynamics contracts to exchange Tomahawk technology with McDonnell Douglas as an eventual co-producer of the missile. Throughout the early Tomahawk development, the program experienced disappointing test failures which led to delays in Fleet introduction. Quality control problems were a major irritant.[40:85] Once these problems were resolved, JCMPO projected to procure 1,861 missiles for fiscal years 1984-1988. The dollar

values of these projected buys were over $4 billion dollars. [40:86]

5. Commercial Communications Spacecraft

The Hughes Aircraft Company, Space and Communications Group led the early pioneering efforts in satellite communications in the early 1960's. Hughes developed and produced the spin stabilized satellite with its successful commercial applications. Hughes-built communications satellites have a reputation for durability; they have a cumulative total of more than 320 years of mission performance in outer space. Hughes maintains a leading market share of sixty percent of all current communications satellites. There are forty five Hughes built communications satellites in operation today. [45]

6. Program Summary

The preceding missiles are primarily joint Service programs with the Navy as the lead service. Each missile system receives support through both Navy and Air Force logistics systems. The Sparrow and Sidewinder programs involve relatively mature production technology with newer models of missiles containing updated components. The Sparrow, Sidewinder, and Tomahawk entail two prime contractors in a competitive environment. Repetitive procurements are projected for each program. Once a missile is launched, it is difficult to pinpoint or identify

particular causes of failures in flight. Significant warranty issues within these programs include:

a. Use of Warranty Assessment Boards for the HARM and SPARROW programs.

b. Leverage of a "no cost" warranty as a negotiation technique for total cost reduction in the HARM program with Texas Instruments.

c. Issue of "no cost" warranties generated by the inclusion of a seven percent of acquisition cost for warranty coverage in the Tomahawk program.

C. WARRANTY CONTRACTUAL ELEMENTS

There is a divergence of opinion as to what actually constitutes an effective warranty contract clause. Some outside influences which affect warranty contract clause construction include equipment type, program requirements, maturity of program, service regulations, the contractor, the quality and depth of contract administration expertise available, and the contracting officer himself. This list of outside influences can be quite extensive. Both NAVAIR and NAVSEA have developed quite similar warranty checklists for ensuring "theoretical" and "essential" items are included in each warranty clause. Figure 3 in Chapter III presents an example of the warranty checklist used by NAVSEA.

In an effort to obtain a better understanding of warranty contract clause construction, at least three contracting or technical personnel with extensive practical experience in warranty application and coverage from each Systems Command were interviewed. The following points

summarize their responses to identifying the major elements in warranty clause management:

- The piece of equipment itself
- Definable and measurable performance requirements for compliance
- Statutory requirements
- Duration of warranty for verification of equipment capabilities
- Maintenance philosophy and need for operational repairs
- Ability to enforce warranty
- Traceability of warranted equipment
- Looking at the economic power of the product--if it is the main product of a company it is easy to enforce; if it is a minor product of the company it is hard to enforce
- Geographic location of failed unit
- Transportability of warranted equipment
- Impact on logistics and maintenance systems
- Statement of work from the prime contractor

The most frequent responses were the "equipment itself" and "identified performance parameters." Taking the above information and NAVAIR and NAVSEA warranty checklists into consideration, the following sections identify key elements in warranty contract clauses. A brief discussion of the primary factors introduces each element.

A comparative analysis exhibits the manner in which five different contract clauses treat that particular element. The five warranty clauses are from the following contracts:

Program	Contract Number
HARM	N00019-85-C-0044
SPARROW	N00019-85-R-0070
SIDEWINDER	N00019-84-R-0063
TOMAHAWK	N00032-85-C-5757
Commercial Communications Spacecraft (CSS)	Hughes Aircraft Company Model Clause, October 1985

1. Contractual Terms

Definitions of key terms in the contract clauses are highlighted. This is done to alleviate any possible misunderstandings between the parties. Each party is working from a common basis in fulfillment of the contract.

Program	Definitions Included
HARM:	Acceptance, Missile Test Set, "Elapsed Time Indicator (ETI) hours", Date of "Return to Texas Instruments", Date of "Return to the Government", HARM Warranty Board
SPARROW:	Acceptance, Guidance-Control Section or GCS, Date of "Return to the Contractor", "Date of Return to the Government", Supplies, Price, Government Mishandling, Lot, Repair, Sparrow Warranty Assessment Board, Failure, Breach, Design and Manufacturing Requirements
SIDEWINDER:	Acceptance, Supplies, Price, Government Mishandling and Misuse, Lot, Replacement, Repair, Breach, Design and Manufacturing Requirements, Failure, Relevant Failure
TOMAHAWK:	Defect or Deficiency, Correction, Supplies, Design and Manufacturing Requirements, Acceptance, Essential Performance Requirements, Warranted Failures
CCS:	Definitions not highlighted

Three out of four of the Government contracts contained these definitions: acceptance, design and manufacturing requirements, supplies and failures. The definitions of

acceptance, design and manufacturing requirements, and supplies have essentially the same wording. The definition of failure appears as key wording. In the Sparrow and Sidewinder clauses, failures are identified to specific components and test plans. Tomahawk failures are attributable to not meeting the essential performance requirements as defined by a certain Mean-Time-Between Failure (MTBF) level. The definition includes a caveat in stating that warranty failures are not limited to those MTBF failures.

2. Essential Performance Requirements

One of the major keys to constructing an effective warranty contract clause is "verifiable" and "definable" essential performance requirements. Within the context of the new warranty law, essential performance requirements are:

> the operating capabilities, maintenance and reliability characteristics of a weapon system, which is manufactured in mature, full-scale production, necessary for it to fulfill the military requirement for which the system is designed. [3:46.7-3]

The manner in which essential performance requirements are defined in DFARS allows the contracting officer to preclude warranting "nonessential" performance requirements. [4:4] This provides the contracting officer a great deal of flexibility. For example, when warranting the performance requirements of a new CG-51 class cruiser, the contracting officer does not have to worry about warranting the chief's

quarters head. The following is a breakdown of program essential performance requirements:

HARM:
- Captive Flight Reliability MTBF specification compliance, (AS-5044); Initial captive flight warranty assessment not made before a total of 5,000 hours of ETI operation time has accumulated.
- Storage failure rate; Degradation no greater than 5% a year from a sample of 20% of deliverable tactical missiles, each with at least one year of storage.
- Reviewed quarterly by HARM Warranty Assessment Board

SPARROW:
- Sampling of a production lot for four or fewer relevant failures over 1,380 hours of warranty verification testing (WVT). Ten or more relevant failures results in contractor failing WVT.
- Reviewed quarterly by SPARROW Warranty Assessment Board

SIDEWINDER:
- Must meet or exceed 450 hours MTBF.
- Product verification testing (PVT) performed within twelve months after delivery of lot. Government reserves right to test up to twenty four months.
- Lot must have five or fewer failures to pass PVT with a combined lot testing of 1,755 hours. If greater than five failures, each individual lot tested a full 1,755 hours.
- Incoming inspection performed at Naval Weapon Station Yorktown or Letterkenny Army Depot.

TOMAHAWK:
- Individual ship suites allowed seventy five warranty failures per year. Anything over seventy five, the contractor pays.
- Operating capabilities and reliability characteristics identified in Prime Item and Critical Item Development Specifications.

CCS:
- Communications channel meeting performance parameters.
- Channel capable of being successfully operated by Buyer.
- Buyer has twenty four hours notification responsibility if failure occurs.
- Hughes is paid an additional performance incentive amount if communications channels

operated successfully longer than a predetermined length of time.

Each of above clauses describes specific parameters to be met. Sparrow and Sidewinder warranty testing appears to be more of a receipt-inspection procedure. Harm and Tomahawk involve operational usage. The inclusion of warranty assessment boards in the Harm and Sparrow programs provides additional management attention in determining warranty effectiveness. In the Sparrow clause, it cannot be determined what happens between four and ten failures. It is interesting to note that in the commercial warranty the contractor is paid an additional amount of money when he exceeds performance parameters.

3. Duration

Depending on the type of weapon system warranted, the period of warranty coverage can be measured in calendar days, operating hours, or any other suitable measure. Beginning with Government acceptance, warranty duration should be of sufficient length to verify the various warranty elements or parameters. The amount of risk the contractor is willing to assume should also be considered. Two significant factors should be examined before deciding on duration: 1) Installation or deployment schedule; 2) Operating rate. [32:2-13] The following is a breakdown of program duration lengths:

HARM: - Design and manufacturing requirements: three years.

- Material and workmanship requirements: nine months ("Storage" missiles are covered for three years. Storage is defined).
- Specific performance requirements: three years
- Warranty period adjustment: exclusive of time spent in repair or replacement plus thirty days for Government handling.

SPARROW:
- Material and workmanship requirements: three years.
- Specific performance requirements: three years
- Warranty period adjustment: exclusive of time spent in repair or replacement plus thirty days for Government handling.

SIDEWINDER:
- Design and manufacturing requirements: three years.
- Material and workmanship requirements: three years.
- Warranty period adjustment: exclusive of time spent in repair or replacement plus thirty days for Government handling.
- Performance requirements warranted at time of Government acceptance.

TOMAHAWK:
- Design and manufacturing requirements: time of Government acceptance.
- Material and workmanship requirements: time of Government acceptance.
- Performance requirements verify depending on contract line item and contractor.

CCS:
- Performance period is negotiated. It commences on the day the spacecraft is positioned at the geosynchronous orbital location, or sixty days after launch, whichever is earlier.

A three year time period appears to be a relative standard for warranty coverage, with an exclusion factor for repair or replacement time. What is the significance of verifying performance requirements at the time of Government acceptance with the Sidewinder and a three year warranty period

as with the Harm? How much more does the Navy "indirectly" pay for an additional three year time period?

4. Marking

The DFARS maintains that warranted items must be marked in accordance with MIL-STD-129, "Marking for Shipments" and MIL-STD-130, "Identification Marking of U.S. Military Property." [3:46.7-2] This leaves open the specific data elements of a warranty identification "nameplate". NAVAIR requires the following marking elements: [35]

"Warranted Item"

Contract number of procurement

Expiration of warranty

Where to ship the item while under warranty

The marking medium can involve: 1) metal plate, 2) tag, 3) self adhesive decal, and 4) log book records. Bar coding and laser etching are future initiatives in the marking area. The following is a breakdown of program marking requirements:

HARM:
- Indication a warranty exists
- Expiration date
- Whom to notify if the item is found to be defective
- Expiration date adjustment for repair or replacement time

SPARROW:
- Each "severable" component and contractor shipping container to indicate warranty exists
- Disassembly of warranted unit not authorized in the event of failure
- Expiration date

- Contact "NAVAL AIR SYSTEMS COMMAND, AIR-42011D" in the event of failure

SIDEWINDER:
- Expiration date adjustment for repair or replacement time
- (Specific requirements provided in separate attachments to contract which are not available)

TOMAHAWK:
- Not addressed in warranty clause

CCS:
- Not addressed in warranty clause

Three of the clauses reviewed have similar marking requirements, but not identical. The HARM and Sparrow requirements require notification in the event of failure. What should be done with the failed unit while awaiting disposition instructions? None of the clauses required the contract number and lot number be marked on the warranty label. This may cause trouble in trying to track the unit. The NAVAIR marking requirements were published after the above contract clauses were negotiated.

5. Repair and Corrective Action Responsibilities and Remedies

The DFARS provides the contracting officer three possible remedies to invoke if the warranted item fails during the agreed upon warranty coverage period. These remedies include but are not limited to: 1) Contractor correction of failure, 2) Government correction of failure, and 3) Equitable contract price reduction. [346.7-4] With contractor correction of a failed unit, no additional costs may be charged to the Government in terms of an increase in: 1) price of a fixed-price contract, 2) target or ceiling

price of an incentive contract, and 3) estimated costs or fees of a cost reimbursement contract. This essentially translates into the contractor bearing the transportation costs to and from a repair facility. [4:6]

Using the option of Government repair can remove restrictions in meeting Fleet readiness objectives by having shipboard repair. Should a predetermined Government cost calculation be included in the contract for consistency in reimbursement? What avenues are left to the contractor for failure verification if this option is exercised?

The third option, "an equitable contract price reduction" sounds fine in theory, but may prove difficult to apply for some of the same reasons mentioned above. This appears to leave the door open to litigation because of the vagueness of its regulatory basis. [4:6] The following is a breakdown of program repair and corrective action responsibilities and remedies:

HARM:
- Design and manufacturing requirements: contractor repair or replace failures.
- Material and workmanship: contractor repair or replace failure if the failure adversely affects the performance, durability, reliability, interchangeability, effective use or operation, weight or safety of the warranted item. The Government is entitled to an equitable adjustment in contract price if the defect does not affect the previously mentioned elements.
- Performance requirements: Contractor repair or replace failure; if not, contractor pays costs incurred by Government in procuring replacement item.

SPARROW:
- The contractor inducts failed units for repair under a previously established repair

delivery order. The Government is reimbursed a percentage of repair cost. The percentage is calculated by a formula specified in the contract. Failures are determined through warranty verification test (WVT) procedures.

SIDEWINDER:
- Contractor repair or replace failures.
- If the contractor has the inability to repair or replace or if the Government does not require repair or replacement, the Government is entitled to an equitable adjustment in price.

TOMAHAWK:
- Design and manufacturing, material and workmanship requirements: Contractor repair or replace failed items or furnish to the Government the necessary materials, parts, and installation instructions to affect corrective action.
- Performance requirements: Contractor pays all costs of repair or Government entitled to an equitable adjustment.

CCS:
- Buyer entitled to a prenegotiated "Spacecraft Performance Warranty Payment" for failure.

To make the contractor truly responsible, the scope of his corrective actions must be precisely defined to avoid problems. The above clauses provide definitive guidance on who does what within each remedy. In determining an equitable adjustment, the contract clauses could be more exact. Only the Sparrow clause provides specific calculations for determining payment. If specific cost elements were included upfront when determining reimbursement charges or equitable adjustments, then negotiation with the contractor may be simpler. In reality the contracting officer who negotiated the original warranty clause will probably not be the one who decides on remedy action. The above contract clauses seem to be limited

only to the three remedies provided in DFARS. Those warranty clauses may prove more effective and concise if some of the following areas were also taken into consideration: [46:16]

- Installation of replacement parts (including item tear-down and reassembly).
- Repair or replacement of secondary damage resulting from failure of warranted parts (excluding consequential damage).
- Redesign.
- Providing and/or installing retrofit parts.
- Revision of manuals and other technical data.
- Modification of support equipment.
- Provisioning of consignment spare parts.

Recognizing that each situation is unique, warranty remedies should be tailored and not limited to any particular set of remedies.

6. Turnaround Time

When the warranted item is in critical short supply or of high dollar value, turnaround time is a critical element of the contract clause. Specific and enforceable time limits must be considered. The inclusion of liquidated damages for not meeting specified times may preclude future litigation.[46:16] Another factor to consider is how long it takes organic Navy repair activities to fix that particular item. Are consignment spares being utilized to cover the system shortfall of the failed item? The following is a breakdown of program turnaround times:

HARM: - ninety day turnaround time, provided that the rate of return does not exceed ten per month.
- Turnaround time with return rate greater than ten per month to be negotiated.

SPARROW: - One hundred twenty day turnaround time, provided that the rate of return does not exceed ten per month and "parts are available."
- Circumstances other than above to be negotiated.

SIDEWINDER: - Contractor shall use his best effort to repair/replace failed units within one hundred eighty days and in no event shall time to repair take longer than twelve months, provided return rate does not exceed twenty five per month.

TOMAHAWK: - Not addressed

CCS: - Not addressed

A wartime scenario may completely revise turnaround times. Instead of saying "with a return rate greater than ten, turnaround time to be negotiated", it might be more effective to include a graduated turnaround time schedule or provide the contractor with an incentive pool to meet turnaround times. Conversely, provide some type of penalty or liquidated damages if turnaround times are not met. The Sidewinder Program provides a six month "grace" period for not meeting turnaround time requirements.

7. Transportation

The Navy operates worldwide. Transportation costs can be significant if shipping a large item from the middle of the Indian Ocean. If these transportation costs were for warranty failures, it would seem obvious that the contractor would pay for the transportation costs. This is

particularly true if the warranty remedy used "requires contractor to promptly take corrective action, as necessary, at no additional cost to the Government." [3:46.7-4] The following is a breakdown of program transportation elements:

HARM: - Government bears the cost of transportation to the weapons station (in CONUS). Contractor bears the transportation costs for all sections between the weapon station and the contractor's plant and subsequent return to the weapon station (in CONUS).

SPARROW: - Same as above with the exception that the transportation cost is based on a percentage. This percentage is the same as used in calculating repair reimbursements.

SIDEWINDER: - Same as HARM

TOMAHAWK: - Contractor bears the transportation cost from the place of delivery specified in contract to the contractor's plant and return.

CCS: - Not applicable

All four Government transportation clauses are essentially the same. It is not clear to this researcher that if the Government invokes the contractor correction remedy, why the Government should share the transportation costs with the contractor. The transportation cost from any overseas point to CONUS is, in effect, an increase in the price of the contract.

8. Additional Special Clauses

The following discussion highlights special clauses in each warranty contract clause not mentioned previously.

HARM: - Responsibilities of HARM Warranty Assessment Board
- Use of specifically identified test equipment for verifying failure.

- Installation of seals to minimize unauthorized repair attempts.

SPARROW:
- Contractor maintaining a separate cost account for cost of administering warranty clause
- Responsibility of SPARROW Warranty Assessment Board.
- Inclusion of a nonrelevant failure category. (For example, failure determined to be the result of operator error).
- Detailed logistics handling plan for handling warranted items.

SIDEWINDER:
- Submittal of failure analysis report by contractor on each failed unit.
- Detailed marking requirements.

TOMAHAWK:
- If contractor found not to be in breach of warranty after complying with Government direction, the contractor is compensated under the "Changes-Fixed Price" clause.
- Specific contractor notification requirements of failed unit.

CCS:
- Simply stated performance requirements.
- Equitable adjustment for partial performance.
- Refund of performance payments for failures.

Because each situation is unique, anyone of the above special elements could be incorporated into other warranty clauses for more effective warranty administration.

9. Clause Summary

Each of the warranty contract clauses reviewed demonstrated innovative warranty management techniques. More consistency between clauses in marking requirements and failure reporting procedures would seem to promote effective warranty management at the user level. This is particularly important since each program is a joint Service program with the Air Force. Only the Tomahawk clause mentions Air Force procedures.

Although these clauses were negotiated prior to publication of the Navy warranty policy instruction, these clauses meet the majority of the draft instruction SECNAVINST 4330.XX requirements. The following area of the instruction is not in the clauses: "Segregation of all actual cost data associated with warranty requirements of the contracts is not contractually required."

The contractual requirement of a quarterly review by a warranty assessment board provides an excellent management tool for gauging warranty effectiveness of a particular program. As mentioned previously, establishing a warranty assessment board for each program may prove difficult or time consuming.

Tailored clauses fit the contract to the situation. Each situation is unique as can be discerned from the preceding clause comparison. This is effective only if the Fleet user can operate within one warranty administration plan. For example, an ordnance type on a carrier may be faced with separate warranty programs while maintaining Harm, Sidewinder, and Sparrow missiles. Warranty contractual requirements must be structured so that the user is provided with enough information to effectively utilize the warranty.

D. EFFECT ON NEGOTIATIONS

As with any new way of doing business, the new warranty law has varying degrees of impact on negotiation.

Contracting officers have been forced to get up to speed quickly on warranty statutory requirements and the intricacies of applying cost/benefit analysis to warranty coverage.

Contracting officers were interviewed from each of the three Hardware Systems Commands in an effort to pinpoint the impact of warranties on negotiations. The following are the major points from those interviews:

1. During the first year of implementation, negotiations of warranty terms, conditions and costs were often protracted and contentious.

2. In a sole source situation, negotiating a "no cost" warranty is difficult.

3. In a competitive situation, warranty requirements can be used as an additional negotiation technique or evaluation criteria.

4. Negotiating warranties often prolongs total negotiation duration. (No particular time element was defined.) This increase in time leads to an increase in costs, both in dollars and manhours.

5. There is increased involvement of technical personnel in negotiations to decipher design and manufacturing requirements and essential performance requirements.

The above points underscore the high learning curve involved with warranty negotiations by both the contractor and the Government. This rate of learning was restricted by the fact that the warranty law requirements changed in successive years. With an upfront investment in time and training in warranty applications and cost/benefit analysis for contracting personnel, the negotiations learning curve

can be improved. Excellent dividends will result once the warranty is operational.

E. CHAPTER SUMMARY

This chapter attempted to highlight the principal contractual elements of a warranty clause. Five different contract clauses were compared and analyzed. For the most part, the four Navy clauses reviewed are in compliance with draft SECNAVINST 4330.XX. The commercial warranty reviewed was much simpler in format. Instead of penalizing the seller, the commercial warranty used incentives for performance exceeding established parameters.

Chapter V investigates potential and actual problems encountered in warranty administration. Problems perceived by this researcher with Navy instructions in Chapter III and the contract clauses of this chapter will be brought out in appropriate problem elements of Chapter V.

V. PROBLEMS ENCOUNTERED IN WARRANTY MANAGEMENT

A. CHAPTER OVERVIEW

As with any significant change in a complex process, such as acquisition of major weapon systems in the Navy, problems may arise in execution of the change. Applying warranties to major weapon systems is a drastic change in doing business. This chapter brings out the various problems in administering the new warranty law from actual implementation of the new law to applying contract clauses. This chapter serves to analyze the issues and problems the Navy is having or may encounter with the application of warranties to major weapon systems. The researcher poses several questions within each issue and follows with an analysis and possible answers.

B. COST/PRICING

While the issue of cost pervades most of the following problems with warranties, extra costs may be incurred anytime during the duration of the warranty. Do the benefits of warranties outweigh the extra costs? With Figure 1 in Chapter II in mind, the Government should be willing to buy a warranty if the cost of the warranty is less than the benefits. The contractor should be willing to sell or provide a warranty if the costs are at least covered. As indicated in Figure 1 the warranty coverage

agreed upon will depend on the cost estimates of both parties which will in turn depend upon the reliability of the warranted system. [47:9] General Skantze, Vice Chief of Staff, U.S. Air Force gives this analogy with warranty cost estimates:

> What do you think the reaction would be if the Army or the Air Force said to a contractor, "We want you to build us a 1-megawatt space laser and then guarantee its performance"? Even if he could figure out how to price that warranty we wouldn't be able to pay for it. [48:6]

With weapon systems costs rapidly rising combined with a general tightening of the defense budget, finding money to fund most initial upfront warranty cost (either a separate line item cost or additional profit) becomes extremely difficult. Will warranty cost estimates be encouraged to look optimistic?

The DOD Cost to Produce Handbook, although relatively dated, maintains that the cost estimate of warranties might range from two to ten percent per year of the acquisition contract. [49:24] With state-of-the-art technology and complex design for weapon systems, such as the F/A-18, in all probability the warranty cost would tend toward the upper range. [50:7] In a fair and equitable contract it only seems reasonable that the contractor be compensated for the additional risk he is assuming. The issue is how much of the risk should be borne by the contractor and how should he be reimbursed for it.

In a cost situation this decision on risk in the warranty issue involves a trade-off of the cost of the warranty versus the probable cost to the Government for correction without a warranty. [51:67] In order to effectively make a decision concerning warranty trade-off, an accurate and tailored cost analysis must be conducted both with and without a warranty. To do this requires a significant amount of work. As discussed previously, Navy Systems Command personnel have received little training and were unfamiliar with warranty cost effectiveness analysis.

To make warranty trade-offs, the various cost elements must be separated from the actual cost of the weapon system. There is no assurance that the supplier is not padding the purchase price of the weapon system with costs of the warranty, if the price of the warranty was not included in his bid or proposal. [13:29]

In order to better understand the potentially expensive implication of warranties, discussion will concentrate on some of the direct and indirect cost factors associated with warranty cost development. These costs are essentially those equated with life cycle cost models.

1. Direct Warranty Cost Factors

In determining if a warranty is cost effective, "The analysis should examine a weapon system's life cycle costs, both with and without a warranty . . . ." [3:46.7-5] Therefore all acquisition, operation, and support elements

that are a part of life cycle costs and that are affected by warranty coverage should be reviewed. Table 4 represents those direct warranty cost factors that are determined to be important for warranty evaluation.

TABLE 4

LIST OF WARRANTY COST EVALUATION ELEMENTS

Reliability

Mean time between failure
Mean time between removals
Reliability growth

Maintainability

False-pull rate
False-return rate
Repair time--base maintenance
Maintainability growth

Readiness

Availability
Consignment-spare statistics

Logistic Flow

Pipeline and storage times
Turnaround time
Spares quantities

Acquisition Cost

Unit hardware cost
Test equipment cost
Training cost
Data cost

Support Cost

Support cost per operating hour
Spares cost
Test equipment cost
Field maintenance manpower cost
Warranty administration cost
Shipping cost
Other support costs

Contract Price Adjustments

Operate-time adjustment
Turnaround-time adjustment
Unverified-failure
Noncovered failures
Warranty escalation costs

Transition Costs

Facility cost
Training cost
Manual/test equipment cost
Modification update cost
Inventory cost

Source: [12:388]

a. Reliability

In the case of Mean Time Between Failure, (MTBF), as a measure of reliability, an increase in MTBF will increase production and procurement costs but should decrease repair costs for the manufacturer and the system buyer. A decrease in MTBF may reduce procurement costs but should increase repair costs. [47:10] This cost is an expectation of what the failure rate may be. With an untried weapon system this could prove to be risky. The contractor will obviously require adequate compensation.

b. Maintainability

Although the false-pull rate and false return rate are easily costed, the key question is who should make the determination of which is false. Should another auditor/evaluator be involved or should the Administrative Contracting Officer be responsible? In the contract clauses reviewed in Chapter IV, the Disputes Clause gave the contracting officer the final determination.

A possible solution would be to have a contractor/Government team review possible discrepancies. Warranty Assessment Boards, such as those used in the HARM or Sparrow programs described in Chapter IV, appeared to be excellent examples of such a Board.

c. Readiness

Determining system availability is difficult to measure directly. Failure rates of new equipment tend to

vary bcause of many different factors--untried technology, operator inexperience, optimistic performance predictions, and new maintenance practices. These many different variables translate system availability into an estimate built on many different estimates of future characteristics. The margin for error is likely to be compounded.

d. Logistics Flow

The logistics flow of both failed and repaired units is normally through lengthy traditional supply lines. This requires additional spares. [52:35] Who should manage and pay for those spares? Since it could be a function of the warranty, should the contractor be responsible? How would this interact with various Navy inventory management systems? The contractor's ability to affect dependable repair turnaround times is the key. In the case of the Sidewinder contract clause, the contractor is given a six month leeway in turnaround time.

The researcher has found that maintaining a separate warranty spares inventory alongside the standard Navy inventory management systems may prove cumbersome. Adjusting inventory management models to accommodate warranties is not the answer because of the variability between warranty elements as highlighted in Chapter IV. An alternative to these spares problems may be to adopt a logistics support cost warranty to provide warranty coverage.

e. Acquisition Cost

In evaluating the actual unit hardware costs, the contracting officer might assume that the costs of warranty provisions are not reflected as direct elements of the purchase. How can it be determined that the unit cost is not padded with some warranty cost? [13:29] In the case of the Navy, which will not pay for warranties per se, this is a particularly evident problem. Should the Navy make the contractor cost out warranties separately, similar to new procurement regulations which segregate unallowable costs? Proposed SECNAVINST 4330.XX requires this to be accomplished contractually.

f. Support Costs

Support costs vary with the type of equipment under the warranty and the maintenance required. The amount of warranty administration involved could prove to be the largest undeterminable cost. In a May 1985 Warranty Conference sponsored by the Office of Naval Acquisition Support, (ONAS), the general consensus was that warranty administration is the weakest link in the effective utilization of warranties. (31:VI) The following factors at the field level of warranty administration must be taken into consideration.

- Training of field level personnel on warranty use and recognition.
- Local preventive maintenance.
- Invalidation of warranty seals.

g. Contract Price Adjustment

There are various actions which can affect warranty contract price adjustments. The most prominent adjustment is for unverified-failures. A certain percentage of the Fleet returned failed units will actually be good. In processing these erroneously returned units, the contractor could request the Government to mitigate his incurred costs. If these costs are reimbursed without question, the contractor might be less motivated to reduce these actions through "its design, built-in test equipment, maintenance manuals, and training procedures." [32:2-14]

To equalize these risks, a compromise is recommended by reimbursing the contractor for unverified failures that exceed a preestablished percentage of all returned units. For example, avionics warranties generally exhibit rates between twenty and thirty percent. Anything above that rate, the contractor is reimbursed for unverified failures. The contracting officer must balance these costs and risks. [32:2-14]

h. Transition Costs

The various costs involved with shifting "ownership" of a weapon system from the contractor to the Government may be avoided by planning early in the weapon system development cycle. One cost that would be hard to quantify early would be the cost of modification to equipment as the result of failure history.

This cost of modification to equipment will vary with the addition of warranties. The contractor will tend to apply most attention to the front end of the warranty where there is some assurance of payback before the warranty expires. [13:29] Toward the end of the warranty, equipment performance suffers. When the warranty expires, the Navy is left with a technological out-of-date piece of equipment.

While the direct costs in Table 4 could be unwieldy to model and estimate, it is not an impossible task. They could allow for comparisons to be made from similar pieces of equipment or historical data. The researcher has found that the Navy does not currently have a comprehensive warranty database to do this.

2. Indirect Warranty Cost Factors

Factors affecting indirect warranty costs must also be taken into consideration when evaluating total warranty costs. One source indicated that there are six major factors involved with indirect warranty costs. The factors are contained in Table 5.

The philosophy and strategies that deal with the above factors are more heavily a function of the program office. The cost estimating and negotiating of the indirect warranty costs remains within the role of the contracting officer.

The full impact of any of those indirect warranty cost factors in Table 5 is generally not felt for several

TABLE 5

MAJOR CATEGORIES OF FACTORS AFFECTING INDIRECT WARRANTY COSTS

Category	Definition
Competition	Cost of opportunities in competitive marketplace for acquisition of equipment and parts
Break-Out	Cost of opportunities for break-out acquisition of subassemblies
Warranty Bail Out	Cost to the Government in the event the contractor fails to fulfill its warranty obligations
Technology	Cost of opportunities in technological advances
Second-Sourcing	Cost of opportunities in second-sourcing production units
Readiness	Cost of loss of readiness and failed maintenance capabilities in combat environment

Source: [12:390]

years. An example of this is the cost of competition with warranties. The tremendous impact of competition translates into increased breakout of spare parts and second sourcing. Difficulties arise with managing different warranty administration plans for the same weapon systems, and with the contractor requiring pedigreed parts to maintain the warranty coverage.

In any evaluation of the costs and benefits of warranties, indirect warranty costs factors must be taken into consideration. Indirect warranty costs and the factors driving those costs, nonetheless are extremely difficult to

estimate. SECNAVINST 4330.XX identifies various indirect warranty costs, but does not provide a means for estimating them. This researcher did not find any comprehensive warranty cost estimating techniques which calculated or took into consideration indirect warranty costs.

3. Baseline Approach to Warranties

Appendix D provides a brief description of the three major warranty provisions and methods used to analyze their costs. [53:392] Each method shown is based on estimates of some kind. When analyzing these estimates the following questions must be asked: [54]

a. Was the right technique used for evaluation?

b. What assumptions were used as the basis?

c. How was it applied?

4. Warranty Costing Methodologies

The preceding sections identified various warranty cost factors and categories. Three possible procedures for warranty cost estimation using previously identified cost factors are now reviewed. There currently are no standard DOD warranty cost estimating models. SECNAVINST 4330.XX provides a Warranty Cost-Benefit Analysis Policy Outline. This Outline provides only general guidance and not specifics on costing warranties.

a. Warranty Cost Estimating Relationships (WCER)

While warranty cost could be estimated through a WCER based on size and weight of the system purchase, other

more critical data variables must be taken into account. A simple WCER could be computed as a percentage of unit acquisition cost. For example: [32:4-6]

$$\frac{\text{warranty cost per year}}{\text{unit acquisition cost}} = 4\% + 0.2\% \times (\text{months of discovery period}) - 0.1\% \times (\text{years equipment has been fielded})$$

More detailed WCER's could be developed based on various levels of detail or based on warranty provisions as described in Appendix D.

The ultimate test of any WCER is that it is logical and can predict with some degree of certainty. [55:3-73] While a WCER would be easy to use once developed, the uniqueness between weapon systems and the variability among warranty provisions makes WCER's difficult to apply across the board. In addition, it would require constant refinements. As in the contract clauses reviewed in Chapter IV, each clause was for a similar piece of equipment, but the warranty elements of each clause were considerably different.

b. Bottom-Up Accounting Model

The Air Force Reliability Improvement Warranty, (RIW), Life Cycle Cost Model may be the best current approach as an accounting model. It takes various cost drivers described in previous sections and combines them in

a logical, engineering approach that is designed to include all incurred costs and calculate their sum. [56:Appendix A]

Example of repair cost estimations. [32:4-10]

Repair $ = (cost per repair) x (number of repairs)

$$= \frac{\text{cost}}{\text{hour}} \times \frac{\text{hours}}{\text{repair}} \times \frac{\text{operating hours}}{\text{expected hours per failure}}$$

+ (material $) + (shipping $)

The above example is only a small part of the complete model. Because of the amount of accurate and reliable data involved with the RIW model, this model could prove cumbersome to use and expensive to maintain. Although computer technology could reduce some of the complicated aspects, the model needs to be developed and refined for each weapon system use.

c. Rule-of-Thumb Ratio

A Rule-of-Thumb Ratio for warranty costs can be as simple as: [32:4-3]

$$\frac{\text{warranty price}}{\text{acquisition price}} * = \text{percentage base}$$

*based on historical data from similar programs

Although this ratio provides a quick, rough order of magnitude, it can only be used as a "ballpark" estimate. Because of the high dollar value and variability between different weapon systems, this method should be used as gauge. For final negotiation and proposal analysis, a much more detailed approach should be taken.

5. Warranty Cost Summary

The biggest concern in warranty cost estimation is how to do it. Warranty requirements for major weapon systems have been in place for almost two years. Yet, few management personnel know how to perform a cost estimate analysis or even how to approach it. This causes undue and risky reliance on the contractor to price and cost the warranty as well as the analysis of the contractor's methodology instead of preparing an independent estimate for comparison purposes. [57:63]

This reliance on the contractor for estimating warranty costs is more of a case of "the blind leading the blind." One contractor interviewed stated, "Warranty costing is too hard. All we do is pick a percentage of the unit cost." Where does that leave the contracting officer? The tools a contracting officer currently has for an independent cost analysis, specifically those in warranties, often fall short of what is needed for sound business decisions. Educating contracting officers on the various cost models available is the first step for improving this. The Navy should investigate the use of computerized cost models, such as the Army "WARM" Model and the Air Force PPAC Life-Cycle-Cost/Breakdown Structure Model. Both of these systems can be used with telephone computer modems.

A 1979 Defense Audit Service (DAS) report highlighted several problems caused by lack of knowledge by

DOD procurement personnel who did not have a specific knowledge of the extent and reasonableness of costs for warranty coverage. Some of the findings of the audit showed that contractors: [58]

- improperly allocated commercial warranty expense to DOD contracts
- prorated warranty expense to all DOD contracts, not just those with warranties
- were reimbursed for warranty expense under negotiated contracts as an element of product cost and again as an element of profit

The above findings are relevant to today's warranty contracts. These problems on the procurement side of warranties compound the lack of warranty knowledge problems at the field level.

C. CONTRACT CLAUSE MANAGEMENT

1. Negotiations/Administration

Warranty administration, in the words of Mr. Ken Jackson, in an article for Contract Management is: "Good Luck." Warranty administration will require a tremendous amount of time and effort by Government and industry personnel. According to Mr. Jackson, a sound base--writing, developing, and negotiating the warranty clause, must be created to ensure the warranty is effective. [59:15]

With the significant numbers of variables involved in warranties, buyers and contract administrators must expend more effort in carrying out the contract. This adds to the ever increasing number of regulations with which

contracting personnel must contend. This will only slow down the already lengthy procurement lead time. Table 2 in Chapter II points out several examples of the effect warranties have had on the length of negotiations. What happens in a sole source environment with warranty negotiations? If the Navy requires the weapon system, how is a negotiator going to get a sole source contractor to agree to a "no cost" warranty? As discussed in the Program Background section of Chapter IV, the threat of competition may alleviate this. The ability of the sole source contractor to maintain his market position is one of the essential factors involved.

2. Litigation

Before enactment of the new warranty laws, Federal Agency Boards of Contract Appeals decided only twenty five breach of warranty claims within a five year period. The contractor was awarded relief in more than half of those cases. [4:8] In an interview with the Clerk of the Armed Services Board of Contract Appeals in June 1986, it was found that there were no cases pending or decided concerning the new warranty laws. A review of the Federal Legal Information Through Electronics (FLITE) database confirmed this.

It is this researcher's view that from a contractual standpoint current warranty administration, within the context of the new warranty law, leaves itself wide open to

litigation. The following are only a few examples which could lend themselves to contractual litigation.

a. The burden of proof is placed on the Government in proving claims against the contractor. A situation such as a missile failure in flight may prove difficult to resolve. [60:52-55]

b. The Government is responsible for providing timely notice that the warranty has been breached. The definition of timely notice would have to be constructed to reconcile the possibilities of ship deployments and a war time scenario. [60:52-55]

c. If the contractor warrants a weapon system that the Government provided by the design and specifications, the Government may run into problems recovering on that warranty. [60:52-55]

d. If a warranted item sustains combat damage to part of the equipment, what are the effects of the warranty on the complete system? [60:52-55]

e. If the Navy repaired a warranted item, the contractor is responsible for reimbursing the Government the "reasonable" cost of repair. The contractor may be able to prove that the Navy did not take all the reasonable steps to exercise the warranty before doing repairs. The issue of a "reasonable" cost definition surfaces. The contractor may want to apply commercial rates. [17:35] Of the five contract clauses reviewed, only the Sparrow clause provided specific cost calculations. An example from this weapon system is:

percentage of added repair cost =

$$100 \left[1 - \frac{1380}{N} + \frac{411.25}{N} \quad \frac{1}{550} \right.$$

N = the number of failures (5 or more) experienced in Warranty Verification Testing

f. If the "likely" cause of a warranty failure has been determined to be the result of the contractor's design, material or workmanship, the contractor assumes the burden of proof that his work did not cause a failure. What evidence is afforded to the contractor when the weapon system is lost to hostile fire or is completely destroyed? This possible problem would first have to be resolved by the Government, as mentioned above. The Government must

produce evidence that the failure was the result of contractor performance. [1:616-626]

g. If the Government could have prevented a breach of warranty, the Government cannot recover any damages under the warranty. Can a contractor prove that the warranted item did not receive the proper preventive maintenance? Will the contractor now dictate fully what type of maintenance and repair parts will be used on "his" system? [1:617-626] This could be to the Government's advantage. The contractor now may be more motivated to become involved earlier in the planning of a weapon system maintenance plan. A better coordinated and comprehensive maintenance plan may result.

D. TECHNOLOGY

Weapon systems are frequently on the "leading edge" of technology. Forcing the contractor to warrant an untried system may lead to undesirable results. Admiral James D. Watkins, then the Chief of Naval Operations, in testimony on warranty provisions before the Senate Armed Services Committee stated:

> Many military products necessarily involve state-of-the-art technology, are required to operate in extremely hostile and unforeseen environments and must tolerate abuse well beyond that found in the home. [61:44]

This state-of-the-art technology must be responsive to a military threat. The various threats to national defense are continually changing. This in effect changes the mission performance of the weapon system. Increasing performance often involves technological superiority. Will warranties hinder contractor pursuit of advanced technological solutions to different threats? [21:28]

With changes in state-of-the-art technology, contractors are subjected to additional technical risks. The potential for increased warranty exposure is raised. With this in mind, will a contractor be motivated to stay with tried and proven techniques to reduce his risk rather than new and innovative approaches? [61:44] These technology issues are tough to quantify. The long range aspects of and answers to this issue place it beyond the scope of this research. A suggestion would be to have an organization like the Defense Advanced Research Projects Agency monitor this effect of warranties on technology development.

A side effect of new technology with warranty coverage is that failure rates of new equipment are more difficult to estimate. [61:44] A warranty might not be cost effective if the new equipment has a very low failure rate.

E. COMPONENT BREAKOUT

Under the theme of competition and cost savings, procurement of spares from contractors other than the prime weapon system contractor is heavily stressed. Warranty coverage may reduce any possible gains from this program. The Navy, in order to maintain its warranty of a particular weapon system, has little choice but to buy pedigreed parts from the prime contractor. [13:24] What happens in the case of two or more contractors producing the same systems, (as was the case in three out of four contract clauses reviewed in Chapter IV)? Can parts be interchanged between

contractors? Requiring this contractually may be part of the solution.

This is an extremely significant issue in terms of the costs and time involved in administering different warranties for the same system. This researcher recommends that a possible way to avoid this in the front end, is for the program manager and contracting officer to take the additional costs into consideration when the program acquisition strategy is generated. A waiver can be requested if the warranty is not cost effective.

If the Navy insists on component breakout in conjunction with warranty coverage, the prime contractor could end up charging the Navy more money to compensate for his risk of warranting a system over which he has little control. [50:8]

It appears that warranties and component breakout may run in different directions. One may say the Navy could get warranties on any parts that were broken out from the original contractor, but with the large number of different components involved in a weapon system and the associated warranties, administration of these warranties would soon become an administrative nightmare.

F. GOVERNMENT FURNISHED EQUIPMENT (GFE)

The Government furnished equipment problem is similar to the component breakout problem discussed above. For example, a particular GFE component, which is separately

guaranteed by the GFE contractor is critical to the overall performance of the complete weapon system. Now the prime contractor must warrant the complete weapon system, which includes the GFE. Even though the prime is only responsible for the correct installation of the GFE, the complexity of risk assumption increases considerably. Who should be responsible? Should the Government pay the contractor to manage the GFE warranties? What happens when the GFE causes the contractor's warranted equipment to fail? [62:4.7] These risk factors should cause the Government to reexamine the inclusion of GFE in the weapon system. If these additional risks translate into significant costs, the Government might be better off having the prime contractor provide the total system without GFE, if possible. A good illustration of part of this problem occurred with the production of UH-1H aircraft for the Army. The aircraft itself was covered under warranty by the prime contractor. GFE used in production of the aircraft was also covered under warranty by the GFE manufacturer. When the GFE was received and installed, the warranty paperwork was inadvertently discarded by the contractor. Even though, in this case, the problem was the prime contractor's making, causing the prime contractor to accept additional risk or increasing his own warranty administration will invariably cost the Navy more money. [63]

G. SUBCONTRACTOR/SMALL BUSINESS

Along with the component breakout issue, warranties may generate fewer occasions for small contractors to get involved with spare parts contracts. Although subcontractors and small businesses are not one in the same, several of their problems with warranties are related.

Requiring subcontractors to provide performance guarantees may force small and medium-sized firms out of the defense industry. The small business should have enough reserve capital to accommodate any penalties incurred from performance guarantees. [64:25] What happens if the firm goes bankrupt because of warranty coverage? Where does the Government step in?

A majority of the Navy Systems Commands personnel interviewed felt that this was not a salient issue. The tone of their responses was if the contractors buckle down and do the job that they are capable of, the cost impact should be negligible.

Prime contractors may be in a difficult situation with subcontractors, where in the subcontractor is a sole source to the prime contractor. The subcontractor could refuse any flow down warranty clause requested by the prime contractor. If the prime contractor cannot "make" the required part and is forced to "buy" the part from the subcontractor, the prime will have to absorb any warranty coverage or pass it on to the Government. [65:6]

H. COMPETITION

Each one of the preceding issues could hinder competition in some form or the other. In a leader-follower scenario for example, contractors may refuse to undertake any contract in which they must provide a performance warranty on a weapon system not of their own design. Prime contractors may run into the same problems with subcontractors who are not willing to guarantee another's design. This may cause prime contractors to perform more work in house rather than subcontract out. The issue of financial reserves to pay possible penalties also may limit the number of entries in the defense market. [62:5.5] With the Navy's heavy emphasis on competition, which is illustrated by the three out of four dual source contract clauses reviewed previously, the Navy has to track two different contractors for the same system in order to exercise the warranty. Are these situations taken into consideration singularly or jointly when determining warranty cost effectiveness? In this researcher's view, this should be a program manager's responsibility. In developing his acquisition strategy, the program manager has the overall picture on program costs. Close coordination between the program manager and the contracting officers for each source is a necessity.

I. LOGISTICS/PROGRAM MANAGEMENT

With extended-life programs keeping weapon systems in operation longer, warranty coverage might not extend over

the entire life cycle of the weapon system. [66:37] If this is the case, there are a number of factors that must be taken into consideration to maintain support of the equipment.

1. Funding must be retained in the program for transfer of ownership cost.
2. Technicians and maintenance facilities must be available for repair.
3. Technical manuals and spare parts must be in sufficient quantities to support maintenance.
4. Did the original contract contain an option for extended warranty protection? [67:10]

The key to warranty transfer is planning. The Navy, because they did not service the equipment, might not have the experience to do the planning. To avoid this problem, would the Navy be locked into the same contractor in extending the warranty? The Army approaches this problem by directing that maintenance levels and functions necessary for normal support operations be the same during the warranty time period and also with the time period following warranty expiration. [27:7] This in effect forces the planning upfront in consideration of a total life cycle maintenance plan.

J. READINESS

Two aspects of readiness must be viewed with the effect of warranties: operational availability and sustainability. Failed systems under warranty must either wait for the contractor to fix it on site or be shipped back to the

contractor's plant. This adds up to extended downtime for the equipment. In a wartime scenario, the contractor will be hard pressed to keep up with demands for repair service. Would the Navy supplement the contractor with military personnel? If the contractor has other defense related work, this only compounds the problem. [50:8] What effect does this have on surge and mobilization capabilities?

During the research, no piece of literature or interviewee addressed these issues. This researcher observes that this possible conflict between readiness and warranties will only be brought to the forefront when, in an emergency situation warranties lead to a mission failure.

It would be hard to imagine an aircraft squadron commander explaining to his Type Commander he cannot carry out his mission because his planes are awaiting contractor repair. That squadron commander would do everything in his power to make his aircraft ready. Warranty or not, he would find a way to fix his aircraft. Problems of invalidating a warranty would be far from that commander's mind.

K. OTHER PROBLEMS

The following section briefly presents a variety of problems that can be incurred in warranty coverage.

1. Item Marking

When the equipment reaches the field, there is little guidance to field personnel in identifying warranty equipment. While MIL-STD-129F attempts to standardize label

format, there are still problems with the lack of sufficient information about warranty terms placed on the equipment itself. [68:11] This leads to the question of the value of a warranty if the person owning the equipment does not know he has one. Until SECNAVINST 4330.XX is published, there is no standard marking requirement within the Navy. As reviewed previously, each Systems Command has different requirements. This problem also extends to the Services. Which Service marking requirements should be used on a joint Navy/Air Force program such as the HARM or TOMAHAWK?

Amending MIL-STD-129F to include specific warranty elements and the format in which they are applied, may provide a solution. The Army marking requirements outlined in Chapter III provide a good basis for doing this. With specific warranty data elements required, flexibility must be provided by giving the Services the option to include additional elements.

2. Testing

Large dollar amounts of warranty coverage could depend on a small test sample. [11:5-62] Because of the many different operating environments in which a weapon system must operate, testing in laboratory conditions might do injustice to any kind of performance guarantees. The same piece of Navy equipment can be called upon to operate in both the tropics and the arctic. Two of the contract clauses reviewed called for lot testing at a specific site.

If a lot sample passes its warranty inspection, does the Navy have a claim if one of the untested missiles in the lot later fails? This appears to be an issue of whether or not the defect or failure is latent. "If the defect could have been discovered by a test specified in the contract it is not latent." [1:600] To negate these possible testing problems, the Navy must be extremely careful with how its sampling plans are constructed. Maintaining high confidence levels in sample testing requires larger samples and therefore additional costs.

3. Field Level Problems

a. Maintenance

To maintain the warranty any sensible contractor should want to periodically inspect and perform preventive maintenance on "his" equipment. Is the Navy in the position of maintaining a contractor workforce alongside its ships and aircraft squadrons? How does this affect security? [13:32]

This researcher would observe that maintaining this additional contractor workforce with the various security requirements is neither feasible nor cost effective. A more viable option for the contractor would be to contractually require the Government to provide test or operational reports, data or information relative to the operability of the equipment. This provides the contractor

visibility of the performance of his equipment without burden to himself or the Navy.

b. Unauthorized Repairs

In an attempt to trouble-shoot a down piece of gear, a warranty seal may be broken; or an attempt to increase performance of a piece of equipment, a technician may "fine tune" his gear. Any of these actions may invalidate warranty coverage. [68:12] There are few, if any, procedures in place to preclude or identify these situations. Only one of the contract clauses reviewed requires a warranty seal.

4. Transportation

Depending on the clause in the contract, transportation costs could become the responsibility of either the Government or the contractor. Regardless of who pays, there are several inherent problems. [18:14]

a. Will the warranty information on the equipment provide required shipping information?

b. Who will provide any specialized packing containers? Two of the five contract clauses reviewed in Chapter IV specifically identified that the Government will provide specialized containers. This would seem reasonable in view of the fact the Government would provide specialized containers, if there was no warranty. In addition, shipboard storage of specialized contractor designated shipping containers would prove burdensome.

c. Does the Navy have to add another transportation management layer to handle warranty equipment? How much would this affect transportation priority assignment (TP1, TP2, TP3,) of shipments?

d. Who pays the costs of transportation when the contractor determines a failed unit is good? Are the

costs automatically transferred to a previously established repair order? The answers to these questions depend on the situation. Each of the contract clauses reviewed previously, provided different remedies. These remedies ranged from sending the good unit back to the original organization on a Government Bill of Lading (GBL) to providing the contractor with an equitable adjustment. It would appear with these costs, the remedy should be tailored to the contract situation.

e. Most Government repair facilities are in close proximity to the equipment. Could the failed equipment be checked and worked on at Government facilities by contractor personnel?

f. Will the contractor only pay a flat rate for transportation costs? The difference between Diego Garcia and San Diego could be substantial.

5. Miscellaneous

The following is a brief summary of problems identified by Systems Command personnel during interviews. These problems were not addressed in previous sections.

a. Reliability and maintainability are essentially probabilistic occurrences. How can a "failure free" warranty be accommodated with an established MTBF level warranty?

b. What incentives are provided to the Fleet user for not voiding a warranty? The program manager is the individual who decides what type of warranty is used. He is responsible for any savings in program budget.

c. Conducting cost benefit analysis may prove extremely difficult on new systems and will depend on failure data not readily available from older systems.

d. Who establishes which requirements are "essential" under the new warranty law? What defines "essential" requirements?

e. With the Navy's policy on "no cost warranties," the contractor will cover his risk in other areas. One interviewee noted a significant change in manufacturing and engineering labor hours between a nonwarranty RFP and a warranty RFP.

f. What will be the extra amount of workload on the Fleet for warranty administration? SECNAVINST 4330.XX directs that warranty requirements will not burden the Fleet. Can this actually be accomplished?

g. A warranty cost benefit analysis is required for each individual weapon system. However, are the overall system costs of warranty administration taken into consideration by individual weapon system cost benefit analysis?

h. The new warranty law has been in effect for over eighteen months. How can warranty systems management be implemented without overall Navy policy guidance? The Hardware Systems Commands continue to procure warranted weapon systems, but there are no mechanisms in place for Navy-wide warranty administration.

i. How does a contractor warrant a computer system for performance when the MTBF is based on Government provided specifications? What procedures are in place to mark software for warranty identification?

L. CHAPTER SUMMARY

This chapter has reviewed a number of issues surrounding warranty management. These issues included: Cost/Pricing, Contract Clause Management, Technology, Component Breakout, Government Furnished Equipment, Subcontractor/Small Business, Logistics/Program Management, Readiness and a variety of other possible problems. From the review of these issues, it would appear that warranties will surely cost the Navy more money. Even if the contractor supplies the Navy a "no cost" warranty, the effect on component breakout and the resultant decrease in competition will increase costs. Warranty administration will prove to be an enormous undertaking if the advantages to warranty use are to be fully realized. This could add another bureaucratic

layer in weapon system management, which is already overburdened with paperwork.

The warranty effect on technology and readiness is harder to define. The contractor is going to reduce his risk as much as possible to maintain profit. This means staying with proven equipment. A military commander on the other hand, will do anything he can, including invalidating warranties, to carry out his national defense mission.

The variability of "tailored" warranty contract clauses and different Services and Systems Commands warranty management procedures may inject confusion at Fleet level warranty administration. To get any benefit from warranties, a coordinated effort is required from writing the contract clause to reporting failed units on a ship. Are the perceived benefits in increased quality worth all the extra effort?

The final chapter summarizes the research work. Conclusions and recommendations identified by the researcher are provided.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The objectives of this research effort were as follows: to identify warranty management procedures within the Services and the Navy Systems Commands, to review similar warranty contract clauses to highlight the variability in warranty contract clause elements, and to discern any actual or potential problems from warranty procedures developed or implemented and from contract clauses enacted. In accomplishing this, several conclusions were reached.

Conclusion #1--The primary emphasis with the use of warranties in the Navy is to ensure the contractor stands behind his product. Therefore, warranties are used as a mechanism for shifting risk from the Government to the contractor for ensuring product quality. The Navy's un-official policy of "no cost" warranties underscores this. By forcing the contractor to become more involved with the reliability of his product after delivery, a number of benefits can be gained. These benefits range from increased efforts to design reliability into a weapon system to reduced weapon system life cycle costs.

Conclusion #2--Since the revised warranty legislation was passed by Congress over eighteen months ago, the Navy has yet to publish their warranty guidelines, (SECNAVINST

4330.XX). The Army and Air Force have published comprehensive warranty procedures. The Army procedures are most explicit. This is demonstrated by the assignment of warranty management responsibility to specific activities and promulgation of warranty information through warranty technical bulletins and the central collection agency for effective management. The Air Force Warranty Administration Plan presents general policy requirements and is not quite as specific as the Army's. Specific implementation milestones are identified. The Navy draft instruction, SECNAVINST 4330.XX, presents a broad policy framework for Navy Warranty Management. Each Navy Systems Command is left to implement and develop its own procedures such as a warranty management information system. Because of this, the user in the field may be faced with a variety of procedures for warranty management. The impact of warranties at the Fleet level, both in time and money, is far too great to add additional work and confusion with different procedures.

Conclusion #3--Each Navy Systems Command, in attempting to meet the requirements of the law, has used different methods in accomplishing warranty management. This is because of the lack of published Navy-wide guidance. The efforts of the Navy Systems Commands range from published instructions and warranty guideline manuals by NAVAIR to a "wait and see" attitude by SPAWAR. The diversity in efforts

has two serious repercussions: 1) as Navy Systems Commands continue to acquire and warrant new weapon systems, there is no encompassing Navy warranty management system, and 2) redundancy in Navy Systems Commands' actions waste precious manpower and dollar assets.

Conclusion #4--The manner in which warranty clauses are constructed is affected by a number of important factors. The weapon system itself and verifiable performance parameters are the primary factors influencing warranty contract clause construction. Other variables which may affect warranty clauses include:

- program requirements
- maturity of the program
- Service or Systems Command regulations
- contractor providing the coverage
- quality and depth of contract administration expertise available
- contracting officer himself
- user organization's familiarity with warranty handling
- joint service program requirements

Conclusion #5--While DFARS stresses tailored warranty clauses, there are a number of important elements that should be included in each warranty contract clause. Each warranty contract clause must contend with a number of outside variables as highlighted in Conclusion #4. Despite these different variables, a number of elements should be in each clause. The elements include: contractual terms,

essential performance requirements, duration, marking, repair and corrective action responsibilities and remedies, turnaround time, transportation and additional special clauses. Once these elements are established, they should be refined to meet program requirements. NAVAIR and NAVSEA provide various forms of checklists for ensuring the above elements are addressed in each clause.

Conclusion #6--The contractual requirement of a quarterly review by a warranty assessment board provides an excellent management tool for gauging warranty effectiveness of a particular program. Two of the five warranty contract clauses reviewed included provisions for warranty assessment boards. These boards provide an open forum for airing discrepancies and problems between the contractor and the Government. It is recognized that because of money, time, and manpower constraints, establishing warranty assessments boards is not always practical. Warranty problems, however, can frequently be resolved in the front end instead of going through the sometimes lengthy disputes process.

Conclusion #7--The Navy has not established an overall system review for warranty effectiveness. SECNAVINST 4330.XX requires summarized reports on various types of warranty usage data from the Systems Commands. It is not clear what will be done with this information. An informal consensus of opinion questions the actual effectiveness of warranties. No hard facts were uncovered during the

research to determine warranty effectiveness. Some type of formal review process for evaluating warranty effectiveness appears essential.

Conclusion #8--Although serious attempts to quantify and estimate direct and indirect warranty costs factors have been made, such factors continue to be complicated and hard to understand. As outlined in Chapter V, there are many different factors affecting the costs of warranties. None of the cost estimating models reviewed during the research provided a viable method for handling indirect costs. Few personnel interviewed in the Navy Systems Commands knew how to approach warranty cost estimating. This leads to undesirably greater reliance on contractor warranty cost estimates.

Conclusion #9--More consistency between clauses in marking requirements and failure reporting would promote effective warranty management at the user level. Each contract clause reviewed in Chapter IV addressed primary warranty clause elements in a somewhat different manner. Without overall Navy guidance, inconsistent requirements will continue to be enacted. The user is then faced with a multiplicity of warranty requirements. Not only is this an issue within the Navy, but also within the DOD. For example, each of the programs reviewed in Chapter IV is a joint service program with the Air Force. Whose procedures

should prevail? Only the Tomahawk clause mentions Air Force procedures.

Conclusion #10--With the significant number of variables involved with warranty coverage, buyers and contract administrators must expend additional effort in negotiating and administering contracts for weapon systems. This additional effort adds to the ever increasing number of regulations with which contracting personnel must contend. In turn, this only adds to the already lengthy procurement lead time. Table 2 in Chapter II highlights the fact that warranties have added anywhere from three to nine months in negotiations alone. Attempts to resolve or minimize warranty problems ranging from litigation to component breakout and competition issues will also contribute to increased time requirements. A longer procurement lead time ultimately translates into additional costs, both in dollar amounts and manpower assets. This effect must be taken into consideration when measuring overall warranty cost effectiveness.

Conclusion #11--The Navy currently does not have a warranty management information system for providing system-wide visibility of warranties applied. As mentioned in Chapter III, none of the Navy Systems Commands knew completely how many warranted weapon systems they had, nor did they know what provisions were contractually administered. This information could only be obtained by

soliciting each individual program. Some of the problems in Chapter V could be avoided with a comprehensive management information system.

Conclusion #12--Problems of inconsistent marking requirements between the Systems Commands and Services have the most noticeable effect with the user. Standardizing warranty marking requirements has the most visible impact with warranty administration. The user must first know he has a warranted item and the requirements associated with it. Having standardized warranty marking labels facilitates user warranty management. Training for warranty identification and proper utilization is also enhanced.

Conclusion #13--Some of the major problems in administering Navy warranties not mentioned previously are as follows: 1) fixed repair turnaround times do not accommodate excessive return rates, 2) increases in user workload can be expected because of additional warranty management controls and requirements, 3) material handling paperwork lacks notification or annotations that a warranty applies, 4) Systems Command personnel are unfamiliar with warranty cost estimating techniques, 5) there is no comprehensive cross reference document for identifying warranties, and 6) a timely warranty problem resolution mechanism is not available at the user levels. Currently it is difficult to measure the degree of impact of these problems, because of the newness of the requirements. Many

of the above problems should be reduced by effective planning and standardized procedures. Underlying these problems is the issue of potential increases in costs. When evaluating warranty administration problems, the costs involved in rectifying problems must be addressed.

Conclusion #14--As of June, 1986 there were no cases pending or decided by the Armed Services Board of Contract Appeals concerning the new warranty laws. Despite this lack of judiciary precedence, the research literature shows three particular areas which lend themselves to litigation. These areas are as follows: 1) Government burden of proof in warranty claims, 2) timely Government notice of warranty breach, and 3) implied warranty of Government furnished specifications and design.

B. RECOMMENDATIONS

The following are recommendations by the researcher as the result of this study.

Recommendation #1--The Department of Defense should publish and implement warranty requirements that cut across Service lines. Because of the current push to consolidate individual Service programs into joint programs such as the Tomahawk, standardized warranty requirements are essential. At a minimum, warranty marking requirements and reporting format should be the same to promote user administration of warranties. This also applies to the Navy Systems Commands.

Establishing a new military standard for warranty marking labels is a possible method for accomplishing this.

Recommendation #2--The Navy should publish SECNAVINST 4330.XX as soon as possible. This would give the Systems Commands a common basis on which to build their own warranty procedures. Any controversial parts to SECNAVINST 4330.XX can be amended in the future. Including a milestone schedule for implementation action in the Instruction, similar to the Air Force requirement, gives Navy top management a measure for implementation progress.

Recommendation #3--Investigate and provide training to Systems Command personnel on the various warranty cost estimating techniques available. Both the Army and Air Force have developed a number of various warranty cost estimating models. The Navy should review these models for possible use with Navy systems. Spending money upfront in training personnel on warranty application will produce long range savings in time and money.

Recommendation #4--Establish a viable warranty review process process in determining warranty effectiveness within the Systems Commands. This program can be modeled after the Army's warranty assessment program. It includes an annual review of warranty data which includes the following: frequency and types of claims, disputed and denied claims activity, contractor quality modifications, an analysis of the proportional warranty cost to the value of the warranty

services/remedies received. At the conclusion of the warranty, a final evaluation is made deriving the total benefits received against the warranty cost. This information should be made available within the Systems Commands to help in revising and constructing future warranty provisions.

This review process should be established at the program level and the system level. The program level warranty assessment board would be similar to those used in the Sparrow and Harm programs. It should be made up of Government and contractor technical and contracting personnel. Although it is recognized that establishing a board for each program may not be cost effective, boards should be established depending on complexity of the warranty or some predetermined program priority such as acquisition category III (ACAT III).

A total system macro evaluation of warranties should also be accomplished on an annual basis. A board made up of members from the previously established Warranty Ad Hoc Group provides an excellent means for accomplishing this. This board could provide recommendations to the Secretary of the Navy on the actual overall management of warranties within the Navy and whether or not warranties are cost effective from a Navy perspective. This information could be gathered from the program warranty assessment boards, reports required by SECNAVINST 4330.XX, and a warranty

management information system as outlined in Recommendation #5.

Recommendation #5--Establish a Navy-wide Warranty Management Management Information System (MIS). An effective Warranty MIS is a key ingredient to overall Navy management of warranties. Instead of leaving each Systems Command to develop their own system, a single system would alleviate redundancy and promote use. The NAVSEA contract with TECHMATICS, Inc. as described in Chapter III, can provide the basis for this action.

Recommendation #6--Require that contract clauses include graduated repair turnaround times, based on the quantity of failed units returned. In the contracts reviewed in Chapter IV, if failure rate exceeded an established number, the turnaround would have to be reevaluated and renegotiated. It is easier and less time consuming to establish contingency actions for this when the contract is initially negotiated.

Recommendation #7--Establish a warranty failed unit return system requiring minimal effort from the user. This system could be combined with the current repairable retrograde system. When a failure occurs, the user documents the cause of the failure and annotates that a warranty exists on an OPNAV4790.2K form that accompanies the failed unit. The unit is then shipped to a repair "hub" activity such as Naval Supply Center, Norfolk. The "hub"

activity verifies if a warranty exists, retests the unit for failure confirmation and forwards the failed unit to the appropriate contractor. The costs of retesting and transhipment must be weighed against the costs and liabilities of going strictly with the user's verification of failure.

Recommendation #8--Annually publish an index of weapon systems and their applicable warranties. This promotes increased awareness at the Fleet level of warranty usage. This information could be obtained from the warranty management information system described in Recommendation #5. Both the costs for publishing this index and the warranty management information system should be applied as a surcharge in cost estimating models.

Recommendation #9--Mark all issue and receipt documentation, such as a DD1348-1 with warranty annotations. By marking issue and receipt documentation, the individual receiving the equipment is made more aware of warranty application. This procedure would be similar to how SUBSAFE/LEVEL I material paperwork is marked currently. The user is alerted to the fact that special procedures apply. The annotated paperwork could also caution storage personnel that special issue or handling procedures apply.

C. ADDRESSING THE RESEARCH QUESTIONS

The primary research question was as follows:

What are the key problems in management of Navy warranty contract clauses as the result of the new regulations mandating cost effective warranty coverage for major weapon systems and how might warranty administration be improved?

The issues of warranty costs and the estimation of those costs permeate the various problems surrounding warranty management. In addition to being extremely hard to estimate, only a few Systems Commands personnel know how to apply warranty costs. Although current warranty litigation cases could not be identified, the researcher believes it is only a matter of time before the courts get involved. The increasing emphasis on competition and component breakout in the Navy seems to run in a direction counter to warranty coverage. The costs of going with pedigreed parts to maintain a warranty and the difficulties in administering two different warranty plans for the same weapon system are difficult to quantify. The warranty problems with technology readiness are also hard to define with the full effect not being felt for several years.

One method for improving warranty administration is through detailed planning early in weapon system development. Requiring this to be accomplished in the Integrated Logistics Support Plan for a weapon system can help ensure this happens.

Although cost is a major factor, administration of warranties must be carefully analyzed for the Navy to realize the full benefits of warranties. In applying warranties from a contractual standpoint, alternate means of motivating the contractor for better quality should be evaluated. For example, in the commercial contract warranty clause reviewed in Chapter IV, the contractor is given more money from an award/fee pool if the equipment exceeds an established performance level instead of being penalized for not meeting a performance level. It depends on what motivates the contractor.

Warranties will affect almost every facet of major weapon system acquisition and management. The challenge is to identify those effects and plan accordingly.

The subsidiary research questions were as follows:

What is a warranty and how is it applied to Navy weapon systems?

Essentially a warranty is similar to an insurance policy for the buyer in guaranteeing certain product quality requirements. The seller assumes the risk that the product may fail during the warranty period. This shift in risk generally translates into increased costs to the buyer. The Navy's unofficial position is that the Navy should not have to pay the contractor additional amounts of money for something he should be doing in the first place. The Navy

includes the following warranty coverage when deemed cost effective and meeting statutory requirements:

- Design and Manufacturing
- Materials and Workmanship
- Essential Performance Requirements

Each warranty contract clause is tailored to fit the situation and the weapon system itself.

What are the current Navy warranty administration procedures and what are the critical problems in applying those procedures?

The Navy has yet to publish overall policy guidance on warranty administration. NAVSEA has developed generic warranty clauses and published a warranty reference document. NAVAIR, in addition to publishing a warranty reference document and generic warranty clause, has generated command-wide warranty administration procedures. SPAWAR has also developed generic warranty clauses and has conducted warranty training seminars. NAVSUP is in the process of generating supply procedures for managing warranties. There are no established completion dates for the draft procedures mentioned above.

The major problem in applying warranty administration procedures is the lack of consistency between Systems Commands warranty requirements. This compounds problems experienced at the user level.

What are the principal variables or factors which affect warranty administration?

The outside influences which affect warranties include: 1) equipment type, 2) program requirements, 3) maturity of the program, 4) Service or Systems Command regulations, 5) the contractor providing the coverage, 6) the quality and depth of contract administration expertise available, and 7) the contracting officer himself.

The following elements should be addressed in warranty contract clause construction:

- Contractual Terms and Definition
- Essential Performance Requirements
- Duration
- Marking
- Repair and Corrective Action Responsibilities
- Turnaround Time
- Transportation
- Additional Special Clauses

At a minimum each of the above elements should be included in a warranty contract clause.

What significant court cases and Armed Services Board of Contract Appeals cases have occurred involving warranty administration of major weapon systems, and what precedents can be applied?

As of June 1986 it was found that there were no cases pending or decided by the Armed Services Board of Contract

Appeals concerning the new warranty laws. A review of the literature indicated there are three major areas of potential litigation. These three areas include: 1) The burden of proof is placed on the Government in proving warranty claims against the contractor, 2) The Government is responsible for providing timely notice that the warranty has been breached, and 3) Does the implied warranty of Government furnished design and specifications take precedence over a contractor warranty? The above issues are only a few of the examples within the potentially costly litigation arena.

What modifications could be made to existing warranty provisions in order to enhance the administration of such warranties?

Several changes to current practices are included in the recommendation sections. These changes are summarized as follows:

- Establish DOD wide military standard for warranty marking requirements.
- Establish one Navy-wide warranty management information system instead of separate systems for each Systems Command.
- Set up a formal review or assessment process for total system-wide warranty coverage.
- Provide training to Systems Command personnel on the various warranty cost estimating techniques available.
- Include graduated repair turnaround times based on the quantity of failed units returned in warranty contract clause.

- Annually publish an index of weapon systems and their applicable warranties.

D. RECOMMENDATIONS FOR FUTURE STUDY

This research only touched the surface of the many implications of the new warranty requirements for major weapon systems. The following areas are identified for potential research:

1. What is the workload impact of warranties at Fleet Intermediate Maintenance Activities? At organization level units?

2. How should Navy inventory management models be changed to accommodate the use of warranties?

3. How can system-wide warranty administration costs be quantified? These costs include functions such as operation of a Navy warranty management information system. How are these costs included in cost estimating models?

4. What is the long term effect of warranties on the industrial base?

5. How are surge and mobilization capabilities affected?

6. What do operational commanders perceive as the major impact of warranties on unit readiness?

APPENDIX A

LIST OF INTERVIEWEES

The following is a list of people who either were interviewed or directly provided information necessary for this research. Appendix B provides a general list of questions used in interviews. Interviews consisted of both telephone and personal visits.

A. OFFICE OF THE ASSISTANT SECRETARY OF THE NAVY (SHIPBUILDING AND LOGISTICS)

1. Morris, W. R. Capt, SC, USN, Deputy Director Contracts and Business Management, 12 December 1985.
2. Thompson, T., Office of Contracts and Business Management (CBMMA), 22 April 1986.
3. Williams, M., Office of Contracts and Business Management (CBM-CM), 19 June 1986.

B. NAVAL AIR SYSTEMS COMMAND

1. Hein, J. J. Cdr, SC, USN, Deputy Director Missiles and Systems Contract Division, (AIR-216A), 9 June 1986.
2. Hesch, G. F. Cdr, SC, USN, Business/Financial Manager, A6/EA-6, (PMA-234B), 23 June 1986.
3. Harper, S., PCO Harm Missile, (AIR-216A1) 24 June 1986.
4. Muth, R., PCO Sidewinder Missile, (AIR-21611), 19 September 1986.
5. Shields, P., PCO Sparrow Missile, (AIR-21615), 11 September 1986.
6. Goldberg, A., Engineering Support & Product Integrity Management Division, (AIR-5162), 24 June 1986.
7. Rannenberg, J. E. LCdr, SC, USN, Contract Support Services Section, (AIR-21627), 15 April 1986.
8. Deets, D. M. LCdr, SC, USN, Contract Specialist Range Section, (AIR-21624), 26 June 1986.

C. NAVAL SEA SYSTEMS COMMAND

1. Donatuti, R. N., Director Shipbuilding/Overhaul Contracts Division (SEA 022), 18 July 1986.

2. Heffron, M., Assistant Director, Acquisition Planning Division (SEA 901 A), 24 June 1986.
3. Marchetti, R. A. Cdr, SC, USN, Division Director (Business/Financial Management), SSN 21 Acquisition Program, (PDS-3502), 16 January 1986.
4. Kerner, C. W., Acquisition Management and Policy Section, (02C8), 28 July 1986.

D. SPACE AND NAVAL WARFARE SYSTEMS COMMAND

1. Schroeder, J. A., Capt, SC, USN, Deputy Commander Contracts Directorate, (SPAWAR-02), 14 February 1986.
2. Weber, D., Acquisition Plans and Policy Branch, (SPAWAR-2011), 23 June 1986.
3. Sloan, G. D., Production Management Branch, Life Cycle Engineering & Platform Directorate, (SPAWAR-8112), 23 June 1986.
4. Fristch, F., Cost Analysis/Estimating Office, (SPAWAR-8211), 5 August 1986.

E. JOINT CRUISE MISSILE PROJECT OFFICE

1. Nicklas, J. G., LtCol, USAF, Program Manager, Ship System Production & Fleet Engineering Support Division (PMA-2823), 25 June 1986.
2. Cronauer, H. T., Cdr, SC, USN, Business/Financial Manager, Ship Systems Production & Fleet Engineering Support Division, (PMA-2822B), 26 February 1986.
3. McGrath, C. M., LCdr, SC, USN, Business/Financial Manager, Ship Systems Production & Fleet Engineering Support Division, (PMA-2822B), 25 June 1986.

F. NAVAL SUPPLY SYSTEMS COMMAND

1. Barnett, O. T., Cdr, SC, USN, Spares Competition & Logistics Technology, (PML-550), 25 June 1986.
2. Moseley, A. S., Lt, SC, USN, Logistics Plans & Policy Control Division, (SUP-0311), 25 June 1986.

G. SHIPS PARTS CONTROL CENTER

1. Phoenix, W., Harm Missile Program Branch, (SPCC 05224B), 18 July 1986.

H. AVIATION SUPPLY OFFICE

1. Wilsker, O., Acquisition Plans and Policy Office, Contracts Division, 18 July 1986.

I. ARMY

1. Freeman, N., Army Material Command, Product Assurance & Testing Directorate, Warranty Division, 17 July 1986.

J. AIR FORCE

1. Engman, R. A., LtCol, USAF, Officer-in-Charger, Product Performance Agreement Center, Wright-Patterson AFB, Dayton, Ohio, 20 June 1986.
2. Max, J., Deputy Director, Product Performance Agreement Center, 20 June 1986.
3. Howitz, T., 1stLt, USAF, Assistant to the Deputy Director, Product Performance Agreement Center, 20 June 1986.

K. AUDIT AGENCIES

1. Capizzi, D. A., Cdr, SC, USN, Assistant for Investigation (Procurement), Office of Naval Inspector General, 23 June 1986.
2. Johnson, R., Col, USMC, Director, Naval Audit Service Western Region, 22 May 1986.
3. Kruper, G., General Accounting Office, Detroit Regional Office, 7 May 1986.
4. Pennisi, R., Department of Defense Inspector General, Office of Assistant Inspector General, Auditing, 2 May 1986.
5. Husband, W., Headquarters Air Force Audit Agency, Norton AFB, 28 May 1986.

L. DEFENSE CONTRACTORS

1. Russell, J., Contracts Branch, Sikorsky Aircraft Division, United Technologies Corp., Stratford, CT, 13 January 1986.
2. Judson, R., Director of Contracts, Hughes Satellite Division, Hughes Aircraft Company, Los Angeles, CA, 22 May 1986.
3. Gottlieb, S., Director of Contracts, ESL Corp, Sunnyvale, CA, 30 January 1986.
4. Stone, M., Contracts Branch, ARGOSystems Corp, Sunnyvale, CA, 21 March 1986.

APPENDIX B

GENERAL INTERVIEW QUESTIONS

The following is a list of questions used in personal interviews or discussions with those individuals listed in Appendix A. Not all questions were asked of the same individual. Only those questions deemed appropriate for that situation and individual were used.

1. What are your organization's current warranty administration procedures?

2. How has your organization implemented Section 2403 to Title 10 U.S.C. and DFARS Subpart 46?

3. In your opinion what are the principal variables or factors affecting management of warranties for major weapon systems?

4. What is your perceived impact of the new public law requirement for warranties in major Navy weapon system contracts?

5. What problems do you foresee or have encountered in implementing the new warranty requirements in your organization?

6. How would you modify current or planned warranty administration procedures to make them more effective?

7. Do you feel that contractors will provide products of better quality as a result of the system level warranty law?

8. How many weapon systems managed by your organization have been warranted since the new warranty laws were enacted? When will these warranties become "operational"?

9. How are warranties applied within a contractual framework?

10. How do acquisition plans in your organization address the planned use of warranties?

11. Does your organization perform warranty cost/benefit analysis? Is it included with the contract or acquisition plan?

12. How much does a warranty cost from your experience?

13. What are the key elements in putting together a warranty contract clause?

14. Does your organization use any model warranty clauses? If yes, can you provide examples?

15. Has your organization used the DOD or Air Force model warranty clauses? What has your experience been with these clauses?

16. Has the requirement for warranties affected contract negotiations? If yes, in what manner?

17. What determined the amount of field level interaction with warranty contractual requirements? What type of actions were expected from the Fleet user?

18. What is the contractor's role in warranty administration of your program? How was that role developed?

19. What problems do you have in developing warranty contractual requirements?

20. What problems do you foresee in administering the warranty requirements of your program?

21. Who is the key warranty administration person at the contract administration activity who is involved with your program? Would you mind if I contacted him directly?

22. Who is the key warranty administration person at the prime contractor who is involved with your program? Would you mind if I contacted him directly?

23. How were the following key warranty factors developed contractually for your program?
    a. Essential performance requirements.
    b. Proper marking.
    c. Turnaround time/liquidated damages.
    d. Repair and corrective action responsibilities and remedies.
    e. Warranty duration and depth.

f. Investigation of cost responsibility.
g. Enforcement.
h. Tracking.

25. What is your perceived impact of warranties on user maintenance operations and the Navy logistics systems?

26. What is your perceived impact of warranties on defense contractors? Small businesses?

27. Has your organization used or provided warranty data to the Joint Service Data Base, Product Performance Agreement Center (PPAC), located at Wright-Patterson AFB, Dayton, Ohio?

28. Do warranties discourage contractors from bidding on Navy contracts? If yes, why?

APPENDIX C

WARRANTIES BY CONCEPT GROUP [69:4-12]

WARRANTY OF SYSTEMS AND EQUIPMENT UNDER 10 USE 2403

- Essential Performance Requirements Guarantee
- Design and Manufacturing Requirements Guarantee
- Materials and Workmanship Guarantee

EXPANDED WARRANTY OF SYSTEMS AND EQUIPMENT UNDER 10 USE 2403

- Rewarranty of Repaired/Overhauled Equipment
- Repair/Exchange Agreements
- Reliability Warranty
- Maintainability Warranty
- Reliability and Maintainability (R&M) Warranty
- Availability Warranty
- Component Reliability Warranty
- Model Engine Warranty

COMPREHENSIVE PERFORMANCE/ CORRECTION OF DEFICIENCIES CLAUSES

- Model Engine Warranty
- Reliability Improvement Warranty (RIW)
- Mean-Time-Between-Failure Guarantee with Verification Test (MTBF VT)
- RIW with MTBF VT
- Reliability and Maintainability Improvement Warranty (R&MIW)
- R&MIW with MTBF VT
- Availability Guarantee
- Chronic LRU Guarantee
- Spare Parts Level Warranty
- Logistics Support Cost Guarantee
- Maximum Parts Cost Guarantee

SUPPORT/SUPPORT COST WARRANTIES

- Spare Parts Level Warranty
- Logistics Support Cost Guarantee
- Maximum Parts Cost Guarantee
- Method of Test Guarantee

- Test and Repair Improvement Guarantee
- Fault Detection, Isolation, and Repair Warranty
- Quality of Training Materials Warranty

SOFTWARE/SOFTWARE SUPPORT WARRANTIES

- Software Design Commitment Guarantee
- LRU Software Configuration Control and Support Agreement
- Fault Detection, Isolation, and Repair Warranty
- Test and Repair Improvement Guarantee
- Method of Test Guarantee
- Utility Functions Guarantee
- Warranty of Technical Data
- Warranty of Technical Orders

SPECIAL FEATURES WARRANTIES

- Rewarranty of Repaired/Overhauled Equipment
- Repair/Exchange Agreements
- Chronic LRU Warranty
- Spare Parts Level Warranty
- Maximum Parts Cost Guarantee
- Ultimate Life Guarantee
- Commercial Service Life Guarantee
- LRU Software Configuration Control and Support Agreement
- Fault Detection, Isolation, and Repair Warranty
- Method of Test Guarantee
- Test and Repair Improvement Guarantee
- Quality of Training Materials Warranty
- Warranty of Technical Data
- Warranty of Technical Orders

APPENDIX D

WARRANTY PROVISIONS AND COST EFFECTIVENESS MEASURES

1. Defects in Material and Workmanship. The basis for establishing the cost of this warranty coverage is historical claim data. For the initial production buy, data from similar type engine lines (preferably of the same manufacturer) should be used. For subsequent lots, data from the previous lots can be examined keeping in mind that manufacturing quality should be improving and warranty cost decreasing. This is a measure of cost effectiveness for this type warranty.

2. Product Performance Warranty. The primary element of cost for this warranty is the allowance for risk that the engine will not perform according to specification. Assuming the design does work, the only expected claims would be for those low probability failures allowed by the design criteria. The warranty cost should cover these failures. The analyst should assess potential liability by evaluating the cost of deficiencies. The deficiencies and the resulting impacts should be provided by engineering, based upon government experience with similar systems. All remedies specified in the warranty should be included in the analysis. Having estimated the potential liability, the warranty cost can be negotiated based upon expected risk.

3. Reliability Improvement Warranty. The key to cost assessment for RIW is in establishing a reasonable, yet challenging reliability growth prediction for the engine. This can be done by first assessing the reliability at fleet introduction and then applying an appropriate reliability growth prediction technique. A redesign allowance is a significant element of the cost of RIW and should be largest in the first years of acquisition and declining as reliability growth is achieved. The total cost should be set such that if no significant growth in reliability occurs, both the cost allowed for claims and the redesign allowance are more than depleted thereby reducing contractor profit. A well understood reliability baseline is essential. In addition, a multi-year procurement will allow a more realistic assessment and negotiation of costs, especially redesign costs which are not linear with time and are not necessarily proportional to acquisition quantities.

(Excerpt from "A Unified Approach for Pricing Propulsion System Warranties and Guarantees" by Raymond S. Lieber. [53:392])

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